



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

In response reply to:
2007/00701

MAY 22 2008

Dr. Buford Holt, Ph.D.
Environmental Specialist
U.S. Bureau of Reclamation
Northern California Area Office
16349 Shasta Dam Boulevard
Shasta Lake, California 96019-8400

Dear Dr. Holt:

This document transmits NOAA's National Marine Fisheries Service's (NMFS) biological opinion (enclosure 1) based on our review of the proposed Red Bluff Pumping Plant project in Tehama County, California, and its effects on listed species and designated critical habitats, in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*). This biological opinion is based on information provided in the biological assessment, preliminary design report, discussions between NMFS and Bureau of Reclamation (Reclamation) staff, and an extensive literature review completed by NMFS staff. A complete administrative record of this consultation is on file at the NMFS Sacramento Area Office.

Based on the best available scientific and commercial information, the biological opinion concludes that the Red Bluff Pumping Plant project is not likely to jeopardize the continued existence of Federally listed endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), threatened Central Valley steelhead (*O. mykiss*), and threatened Southern Distinct Population Segment (DPS) of North American green sturgeon (*Acipenser medirostris*), and is not likely to destroy or adversely modify the designated critical habitats of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead. NMFS has also included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to minimize incidental take of listed species associated with the project. The ESA section 9 prohibitions against taking of listed species and the terms and conditions in the Incidental Take Statement of this biological opinion will not apply to the Southern DPS of North American green sturgeon until a final ESA section 4(d) rule becomes effective.

Also enclosed are Essential Fish Habitat (EFH) Conservation Recommendations for Pacific Salmon Species, as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) as amended (16 U.S.C. 1801 *et seq.*; enclosure 2). This document concludes that the Red Bluff Pumping Plant project will adversely affect EFH of Pacific Coast Salmon



species in the action area and adopts the ESA reasonable and prudent measures and associated terms and conditions from the biological opinion as well as the recommendations in Appendix A of Amendment 14 to the Pacific Coast Salmon Plan as the EFH Conservation Recommendations.

Section 305(b)(4)(B) of the MSFCMA requires Reclamation to provide NMFS with a detailed written response within 30 days, and 10 day in advance of any action, to the EFH Conservation Recommendations, including a description of measures adopted by Reclamation for avoiding, minimizing, or mitigating the impacts of the project on EFH [50 CFR 600.920(j)]. In the case of a response that is inconsistent with NMFS recommendations, Reclamation must explain its reasons for not following the recommendations, including the scientific justification for any disagreement with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, or mitigate such effects.

We appreciate your continued cooperation in the conservation of listed species and their habitats. If you have any questions regarding these consultations, please contact Mr. Garwin Yip, of my staff, at (916) 930-3611 or via e-mail at garwin.yip@noaa.gov.

Sincerely,



Rodney R. McInnis
Regional Administrator

Enclosures (2)

cc: Copy to file – ARN 151422SWR2007SA00066

BIOLOGICAL OPINION

ACTION AGENCY: U.S. Bureau of Reclamation
Northern California Area Office

ACTIVITY: Red Bluff Pumping Plant Project

**CONSULTATION
CONDUCTED BY:** NOAA's National Marine Fisheries Service
Southwest Region

FILE NUMBER: 2006/04975

DATE ISSUED: MAY 22 2008

I. CONSULTATION HISTORY

On January 30, 2007, NOAA's National Marine Fisheries Service (NMFS) received a letter and enclosed biological assessment (BA, CH2MHill 2007) from the U.S. Bureau of Reclamation (Reclamation), requesting formal consultation on the Red Bluff Pumping Plant (RBPP) project in Tehama County, California, pursuant to section 7 of the Endangered Species Act, as amended (ESA).

From May through August 2007, several phone calls and emails were exchanged between NMFS and Reclamation staff to further clarify the description of the proposed project. Reclamation verified that the demand of the Tehama-Colusa Canal Authority (TCCA) for water was not expected to increase, and there would be no physical constraints on future Red Bluff Diversion Dam (RBDD) operations. Staff discussed potential project impacts to riparian and fish habitat of the Sacramento River and Red Bank Creek. NMFS staff visited RBDD facilities on July 5, 2007. Reclamation staff supplied a copy of the preliminary design report (CH2MHill 2001) to NMFS' Sacramento Area Office; the report was received on August 15, 2007.

This biological opinion is based on information provided in the BA, preliminary design report, and discussions between NMFS and Reclamation staff described above. A complete administrative record of this consultation is on file at the NMFS Sacramento Area Office.

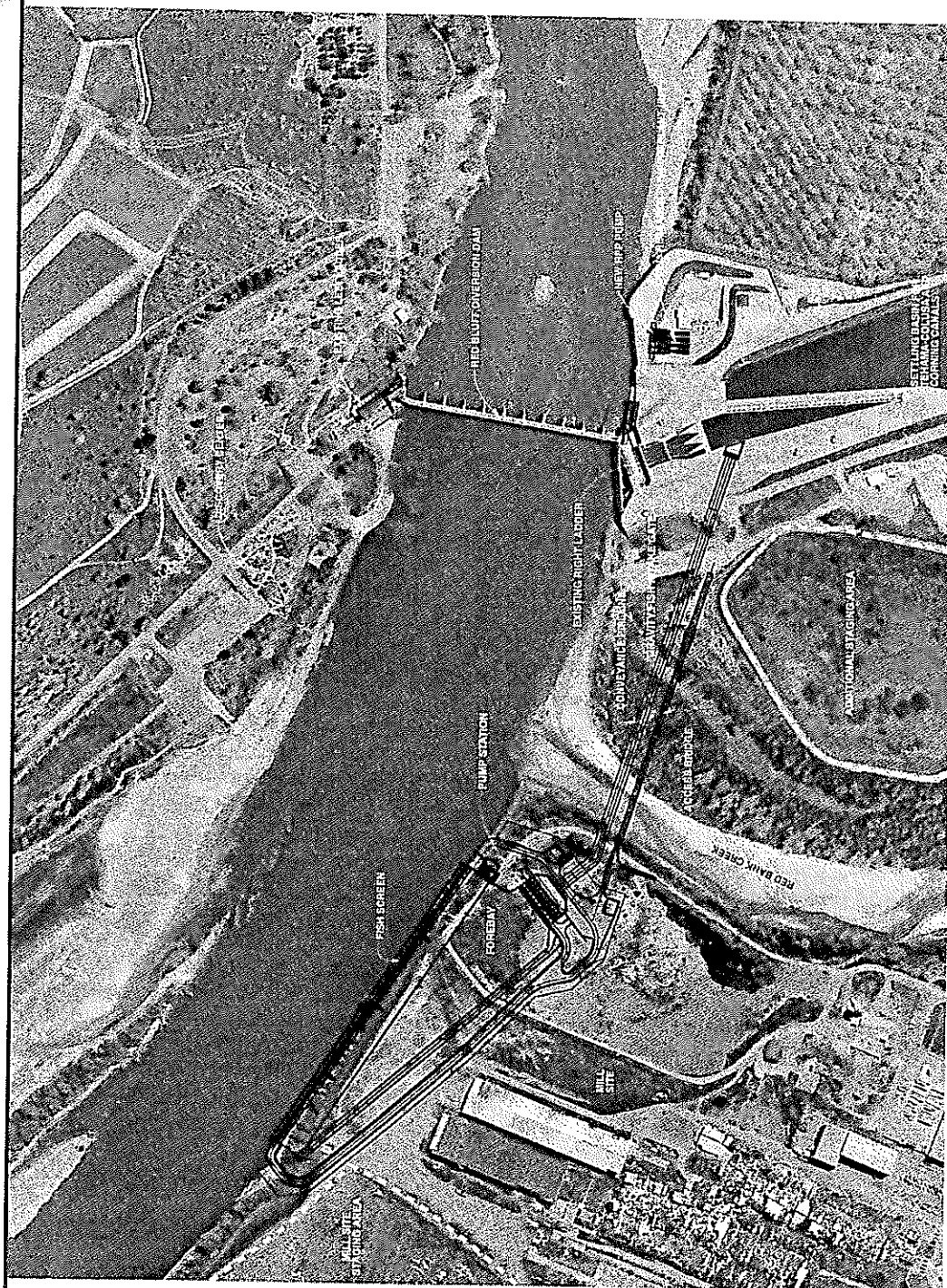


FIGURE 1
GENERAL LAYOUT OF THE
PROPOSED PROJECT FACILITIES
 CONSIDERATION OF IMPACTS TO CHINOOK SALMON,
 STEELHEAD, AND STURGEON FOR A NEW PUMPING PLANT AT
 THE RED BLUFF DIVERSION DAM BIOLOGICAL ASSESSMENT

CH2MHILL

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II. DESCRIPTION OF THE PROPOSED ACTION

Reclamation proposes to construct a new pump station with fish screen at the Mill Site, and install a conveyance facility across Red Bank Creek to convey water from the pump station to the Tehama-Colusa Canal (TCC), on the right bank of the Sacramento River in Red Bluff, California (figure 1). The need for the RBPP project is driven by the continued and well-documented fish passage and agricultural water diversion reliability problems associated with the operation of RBDD, located on the Sacramento River just downstream of the City of Red Bluff. NMFS (2004) discussed these problems in its biological opinion on the long-term operations criteria and plan (OCAP) for the Central Valley Project (CVP) and State Water Project. Even with the current fish ladders in operation, RBDD continues to impede fish passage during the gates-in period from May 15 through September 15. The 4-month window of operation has constrained operation of the dam for diversion purposes to the point that the applicant, Tehama-Colusa Canal Authority (TCCA), cannot reliably meet the water needs of its customers when the gates are out. Construction of the RBPP project will result in no increase in water deliveries compared to current permitted amounts, but will provide greater flexibility to RBDD gate operations (Holt 2007a).

The purposes of the RBPP project are: (1) to allow for substantial improvement in the long-term ability to reliably pass anadromous fish and other species of concern, both upstream and downstream, past RBDD through additional gate openings, if deemed necessary or desirable through future reviews of RBDD operations; and (2) to substantially improve the long-term ability to reliably and cost effectively move sufficient water into the TCC and Corning Canal systems to meet the needs of the water agencies served by TCCA.

A. Proposed Facilities

The maximum capacity of the proposed RBPP is anticipated to be 2,500 cubic feet per second (cfs), which corresponds with the 2,500 cfs approximate existing combined maximum capacity of the TCC and Corning Canal (Holt 2007a, 2007b). This will allow for the eventual retirement of the existing 320 cfs Research Pumping Plant (RPP) while retaining the ability to pump at maximum capacity of 2,500 cfs.

1. Mill Site Pump Station and Fish Screen

The Mill Site pump station and fish screen (hereafter referred to as the Mill Site) are located upstream from RBDD and Red Bank Creek (figure 1). The Mill Site configuration will consist of trash racks, fish screen, forebay, pump station, and conveyance facilities. Most of the site is on a bluff adjacent to the Sacramento River (Campbell 2007). However, in-channel construction will be required to install the fish screen, and will result in the loss of an area of riparian and aquatic habitat measuring approximately 10 feet wide by 1,400 feet long (Holt 2007a, 2007b). Due to monitoring results at other locations and river hydraulics at the site, Reclamation and TCCA staff believe that a fish bypass system may lead to increased predation of juvenile fish; therefore, a fish bypass system is not proposed as part of this project.

The discharge piping would be routed to a new discharge outlet structure at the existing sedimentation basin. Existing drum screens would be removed. When RBDD gates are out, water would be pumped. When the RBDD gates are in, water would be diverted by gravity through the new fish screen into the sedimentation basin. The objective of the positive-barrier fish screen design is to provide safe fish passage for juvenile fish (primarily sturgeon, salmon, and steelhead) past TCCA water diversion facilities.

The screen would be designed to meet all California Department of Fish and Game (CDFG) and NMFS criteria for the protection of salmonids. Reclamation and TCCA have assumed in designing this project that these criteria would be sufficient to protect green sturgeon (CH2MHill 2007). The length of the screen would depend on the characteristics of the river (*e.g.*, depth, channel geometry, flow volume, and velocity under various operating conditions) at the screen location, and is estimated to be 1,400 feet. The screen panels would be installed in approximately 60 bays. Blowout panel(s) would be included as an emergency hydraulic relief system in the event of excessive differential head between the river and the forebay. Bulkhead elevation would be set at the 25-year flood elevation to restrict the amount of debris in the forebay for flood events. Construction of the screen would require a temporary cofferdam to allow the site to be dewatered while the screen panels and appurtenant facilities are constructed.

Water would flow through the fish screen into the pump station forebay and into the vertical propeller pump station. Approximately 10 pumps would be required to achieve a pumping capacity of 2,500 cfs. The pumps would lift the water to the pump station outlet box. The water would then flow by gravity from the outlet box through a siphon under Red Bank Creek. The water would discharge into the sedimentation basin (figure 1).

At Reclamation's discretion, the existing RPP would remain in place, continuing its function as a research station for study of the effects of pumped diversions on fish numbers. The RPP would be operated at the discretion of Reclamation. This facility would not be included as part of the diversions for TCCA water deliveries.

2. Conveyance Facilities across Red Bank Creek

The land where the pump station and conveyance facilities would be constructed is adjacent to land owned by the Federal government for RBDD and is currently available for purchase. Power supply is nearby, and access is in place. Direct access to the pump station site from the existing RBDD site would require a bridge across Red Bank Creek. The conveyance system under Red Bank Creek would consist of pipes or culverts, or their combination, and would be sized for a maximum velocity of 8 feet per second at peak flow. The preliminary design report for the project (CH2MHill 2001) indicates that the conveyance facilities would consist of three box culverts each with a cross-section measuring 10 feet by 12 feet. The discharge structure at the sedimentation basin will be located along the westerly side of the sedimentation basin. The wetted stream channel of Red Bank Creek at the location of the proposed bridge and conveyance system is approximately 100 feet wide when Lake Red Bluff is present (Freeman 2007). The proposed bridge would be approximately 680 feet long by 17 feet wide, and would span Red Bank Creek (CH2MHill 2001). Approximately 160 square feet of fill would be required, and "dense trees" are identified as being present (CH2MHill 2001).

B. Construction Activities

RBPP project would require construction activities at: (1) the fish screen, forebay, main pump station and associated buildings at the Mill Site property for a period of approximately 18 months; (2) the diversion conveyance system and outlet structure running from the Mill Site across Red Bank Creek to the existing TCCA Diversion forebay for a period of approximately 18 months; and (3) the road and bridge linking the existing TCCA diversion site to the new Mill Site diversion for a period of approximately 6 months. Because construction at the sites will be conducted simultaneously, total construction time would require approximately 18 months. Construction will be independent of river flows, RBDD gate operations, and TCCA diversions, and is estimated to be completed by fall 2010. Construction would likely consist of: (1) establishing staging areas, (2) establishing access roads and bridge, (3) installing a cofferdam at the Mill Site, (4) constructing new facilities, and (5) demobilizing and cleaning up.

1. Staging Areas

Before construction, equipment would be brought to a location near the construction site. For the Mill Site fish screen, forebay, main pump station and associated new buildings, a staging area would be located on vacant land at the northwest end of the proposed Mill Site location. Placement of an additional staging area between the right bank of Red Bank Creek and the existing TCCA diversion forebay (figure 1) would allow storage and access of equipment throughout the entire construction location. Vegetation clearing at the staging areas and at the location of each of the construction sites would be required.

Materials and equipment will be stored in staging areas. Typical items in the staging areas will include sheet pile, building materials, support beams, cranes, backhoes, compressors, and various hand tools needed for construction. The staging areas will also be used as a construction crew parking area to accommodate up to 100 construction workers at the height of construction at any of the sites. Access roads leading into the construction site and at staging areas would be fenced to keep the public out of the construction and staging areas.

2. Access Roads and Bridge

The construction of the diversion conveyance system and outlet structure would require construction of a gravel access road across vacant land to the fish screen and pump station location and along and adjacent to the proposed conveyance system. Construction of the access bridge across Red Bank Creek also would be necessary to allow construction equipment and materials to be moved between the Mill Site and the existing TCCA diversion facility (figure 1). Vegetation clearing along the access roads would be required.

3. Cofferdam Installation

After establishing the staging areas, a steel sheet pile cofferdam would be constructed at the Mill Site fish screen work area to isolate construction activities from the Sacramento River. A crane, either on land or on a barge, with a pile driving apparatus, would be used to drive sheet pile to

form the cofferdam around the fish screen work areas. A cofferdam likely would be needed to install the conveyance facilities across Red Bank Creek as well (Holt 2007c). Cofferdam installation is expected to take 4 to 6 weeks. Once the cofferdam is installed, pumps would dewater the area.

4. Constructing New Facilities

In-channel construction would be required in the Sacramento River to install the fish screen, and in Red Bank Creek to install the conveyance facilities and bridge (Holt 2007c). Before construction, site grading and excavation at the various construction locations will be required. Following site preparation, construction of the fish screen facility, pump station, forebay and its associated buildings, and conveyance facilities will utilize standard reinforced concrete construction techniques. Concrete trucks or a batch concrete plant will provide concrete materials to the various construction locations. Then, concrete will be pumped to each facility construction site. Concrete will be formed into the structures necessary for each facility's completion. Although the completed conveyance facilities will pass under Red Bank Creek, trenching in the stream channel will be required to complete construction using this method (*i.e.*, pouring concrete into forms for culvert construction "in place;" Holt 2007c).

5. Demobilization and Cleanup

Cofferdams will be removed following completion of the facilities. Underwater divers will cut the steel sheet pile at the surface of the river bottom before removing the steel sheet pile by crane operating from either a barge or on land. Re-grading of the surrounding areas will also be necessary at the construction sites. Where necessary, re-vegetation will be completed before cleanup. Construction equipment will be moved to the staging area, where it will be trucked back to the construction contractor's storage yard.

C. Proposed Avoidance and Minimization Measures

1. Avoid or Minimize Percussion Impacts to Incubating Salmonid Embryos

Salmonid embryos are sensitive to vibrations following the time of fertilization until the eyed stage of development. Pounding of sheet piles or other materials during construction can cause mortality of developing eggs within redds nearby. To ensure listed salmonids are protected during construction, an exclusionary zone of 200 feet will be identified around the fish screen construction site where pile driving will occur to ensure adequate protection to incubating salmonid embryos.

To minimize the potential for percussion-related impacts (including sound) to Sacramento River winter-run and Central Valley spring-run Chinook salmon, the following minimization measures will be applied:

- If Chinook salmon spawning habitat is in the exclusionary zone, pile driving or other construction pounding will be limited to the period from January 15 to April 15.
- If Chinook salmon spawning habitat is in the exclusionary zone, pile driving or other construction pounding can occur from April 15 through November 15, provided anti-

spawning mats are placed over suitable spawning habitat before April 15. The placement of anti-spawning mats will prevent listed Chinook salmon from spawning within the exclusionary zone; therefore, percussion impacts to salmon embryos will be avoided. Anti-spawning mats will be removed after October 15, or when cofferdams are removed.

- If there is no spawning habitat in the exclusionary zone, pile driving or other construction pounding will be limited to the period between January 15 and November 15.

2. Avoid or Minimize Increased Turbidity and Suspended Sediment

Reclamation will comply with section 401 of the Clean Water Act through issuance of a water quality certification or a waiver from the Regional Water Quality Control Board to minimize the potential effects of increases in suspended sediment and water turbidity for a distance of 500 feet downstream of construction activities.

3. Avoid or Minimize Impacts to Riparian and Shaded Riverine and Aquatic Habitat

The project will avoid and minimize losses to riparian vegetation adjacent to the river channel to the fullest extent possible. Any mature cottonwood trees near construction areas will be flagged and avoided during construction to the fullest extent possible. When loss of riparian vegetation along the river is unavoidable, replanting will occur at a ratio of 3:1 for each woody riparian plant and/or linear foot of shaded riverine aquatic habitat lost because of project construction. The loss of riparian and shaded riverine aquatic habitat is anticipated to occur primarily along the 1,400-foot length of riverbank where the fish screen will be installed (figure 1). Reclamation will work with NMFS, CDFG and USFWS to identify appropriate locations for riparian habitat creation and restoration to compensate for permanent impacts in the action area. For temporary impacts that can be mitigated onsite, a mitigation ratio of 1:1 per woody plant and/or linear distance will be implemented.

4. Avoid or Minimize Impacts to Rearing Salmonids during Fish Screen Construction

The following measures will be implemented to reduce potential impacts to listed juvenile salmonids during installation of sheet pile at the fish screen construction site. The upstream end of the cofferdam will be installed first, and rearing salmonids will be given 1 day to volitionally leave the construction area. Prior to placement of the downstream end of the sheet pile cofferdam and commencement of construction activities, a seine and/or backpack electrofisher will be used by qualified fishery biologists to capture any remaining juvenile salmonids, transport them downstream of the construction area, and release them unharmed into the Sacramento River.

D. Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For the purposes of this biological opinion, the action area encompasses: (1) the lateral 200 feet of the Sacramento River beginning at the right bank, from 200 feet upstream of the Mill Site construction area to 500 feet downstream of RBDD. This area was selected because it represents the upstream and

lateral extents of anticipated acoustic effects from pile driving, and downstream extent of anticipated effects related to increases in suspended sediment and turbidity; and (2) Red Bank Creek, from the proposed location of the bridge, downstream approximately 600 feet to the confluence of the Sacramento River.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

The following Federally listed species evolutionarily significant units (ESU) or distinct population segments (DPS) and designated critical habitat occur in the action area and may be affected by the proposed project:

- Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*), endangered (June 28, 2005, 70 FR 37160)
- Sacramento River winter-run Chinook salmon designated critical habitat (June 16, 1993, 58 FR 33212)
- Central Valley spring-run Chinook salmon ESU (*O. tshawytscha*), threatened (June 28, 2005, 70 FR 37160)
- Central Valley spring-run Chinook salmon designated critical habitat (September 2, 2005, 70 FR 52488)
- Central Valley steelhead DPS (*O. mykiss*), threatened (January 5, 2006, 71 FR 834)
- Central Valley steelhead designated critical habitat (September 2, 2005, 70 FR 52488)
- Southern DPS of North American green sturgeon (*Acipenser medirostris*), Threatened (April 7, 2006, 70 FR 17386)

A. Species Life History, Population Dynamics, and Likelihood of Survival

1. Chinook Salmon

Chinook salmon are anadromous and the largest member of *Oncorhynchus*, with adults weighing more than 120 pounds having been reported from North American waters (Scott and Crossman 1973, Eschmeyer *et al.* 1983, Page and Burr 1991). Chinook salmon exhibit two generalized freshwater life history types (Healey 1991). “Stream-type” Chinook salmon enter freshwater months before spawning and reside in freshwater for a year or more following emergence, whereas “ocean-type” Chinook salmon spawn soon after entering freshwater and migrate to the ocean as fry or parr within their first year. Spring-run Chinook salmon exhibit a stream-type life history. Adults enter freshwater in the spring, hold over the summer, spawn in the fall, and the juveniles typically spend a year or more in freshwater before emigrating. Winter-run Chinook salmon are somewhat anomalous in that they have characteristics of both stream- and ocean-type races (Healey 1991). Adults enter freshwater in the winter or early spring, and delay spawning until spring or early summer (stream-type). However, juvenile winter-run Chinook salmon migrate to sea after only 4 to 7 months of river life (ocean-type). Adequate instream flows and cool water temperatures are more critical for the survival of Chinook salmon exhibiting a stream-type life history due to over-summering by adults and/or juveniles.

Chinook salmon typically mature between 2 and 6 years of age (Myers *et al.* 1998). Freshwater entry and spawning timing are generally thought to be related to local water temperature and

flow regimes. Runs are designated on the basis of adult migration timing. However, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and the actual time of spawning (Myers *et al.* 1998). Both spring-run and winter-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months. For comparison, fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991).

Information on the migration rates of adult Chinook salmon in freshwater is scant and primarily comes from the Columbia River basin, where information regarding migration behavior is needed to assess the effects of dams on travel times and passage (Matter and Sanford 2003). Keefer *et al.* (2004) found migration rates of Chinook salmon ranging from approximately 10 kilometers (km) per day to greater than 35 km per day and to be primarily correlated with date, and secondarily with discharge, year, and reach, in the Columbia River basin. Matter and Sanford (2003) documented migration rates of adult Chinook salmon ranging from 29 to 32 km per day in the Snake River. Adult Chinook salmon inserted with sonic tags and tracked throughout the Delta and lower Sacramento and San Joaquin rivers were observed exhibiting substantial upstream and downstream movement in a random fashion, several days at a time, while migrating upstream [California Bay-Delta Program (CALFED) 2001]. Adult salmonids migrating upstream are assumed to make greater use of pool and mid-channel habitat than channel margins (Stillwater Sciences 2004), particularly larger salmon such as Chinook salmon, as described by Hughes (2004). Adults are thought to exhibit crepuscular behavior during their upstream migrations, meaning that they are primarily active during twilight hours. Recent hydroacoustic monitoring conducted by LGL Environmental Research Associates showed peak upstream movement of adult Central Valley spring-run Chinook salmon in lower Mill Creek, a tributary to the Sacramento River, occurring in the 4-hour period before sunrise and again after sunset.

Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs, and suitable water temperatures, depths, and velocities for redd construction and adequate oxygenation of incubating eggs. Chinook salmon spawning typically occurs in gravel beds that are located at the tails of holding pools [U.S. Fish and Wildlife Service (USFWS) 1995]. Upon emergence, fry swim or are displaced downstream (Healey 1991). Similar to adult movement, juvenile salmonid downstream movement is crepuscular. Documents and data provided to NMFS in support of ESA section 10 research permit applications depict that the daily migration of juveniles passing RBDD is highest in the 4-hour period prior to sunrise (*e.g.*, Martin *et al.* 2001). Once started downstream, fry may continue downstream to the estuary and rear, or may take up residence in the stream for a period of time from weeks to a year (Healey 1991).

Fry then seek nearshore habitats containing riparian vegetation and associated substrates important for providing aquatic and terrestrial invertebrates, predator avoidance, and slower velocities for resting (NMFS 1996). The benefits of shallow water habitats for salmonid rearing have been found to be more productive than the main river channels, supporting higher growth

rates, partially due to higher prey consumption rates, as well as favorable environmental temperatures (Sommer *et al.* 2001).

As juvenile Chinook salmon grow, they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures (Healey 1991). Catches of juvenile salmon in the Sacramento River near West Sacramento exhibited larger-sized juveniles captured in the main channel and smaller-sized fry along the margins (USFWS 1997). When the river channel is greater than 9 to 10 feet in depth, juvenile salmon tend to inhabit the surface waters (Healey 1980). Stream flow and/or turbidity increases in the upper Sacramento River basin are thought to stimulate emigration (Kjelson *et al.* 1982, Brandes and McLain 2001).

Juvenile Chinook salmon migration rates vary considerably, presumably depending on the physiological stage of the juvenile and hydrologic conditions. Kjelson *et al.* (1982) found fry Chinook salmon to travel as fast as 30 km per day in the Sacramento River and Sommer *et al.* (2001) found rates ranging from approximately 0.5 miles up to more than 6 miles per day in the Yolo Bypass. As Chinook salmon begin the smoltification stage, they prefer to rear further downstream where ambient salinity is up to 1.5 to 2.5 parts per thousand (Healey 1980, Levy and Northcote 1981). Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally-influenced sandy beaches and vegetated zones (Meyer 1979, Healey 1980). Cladocerans, copepods, amphipods, and diptera larvae, as well as small arachnids and ants, are common prey items (Kjelson *et al.* 1982, MacFarlane and Norton 2001, Sommer *et al.* 2001).

Within the estuarine habitat, juvenile Chinook salmon movements are dictated by the tidal cycles, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levy and Northcote 1981, Healey 1991). Kjelson *et al.* (1982) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. During the night, juveniles were distributed randomly in the water column, but would school up during the day into the upper 3 meters of the water column. Juvenile Chinook salmon were found to spend about 40 days migrating through the Sacramento-San Joaquin Delta to the mouth of San Francisco Bay and grew little in length or weight until they reached the Gulf of the Farallone Islands (MacFarlane and Norton 2001). Based on the mainly ocean-type life history observed (*i.e.*, fall-run Chinook salmon), MacFarlane and Norton (2001) concluded that unlike other salmonid populations in the Pacific Northwest, Central Valley Chinook salmon show little estuarine dependence and may benefit from expedited ocean entry.

a. Sacramento River Winter-Run Chinook Salmon

Sacramento River winter-run Chinook salmon were originally listed as threatened in August 1989, under emergency provisions of the ESA, and formally listed as threatened in November 1990 (55 FR 46515). The ESU was reclassified as endangered on January 4, 1994 (59 FR 440), due to increased variability of run sizes, expected weak returns as a result of two small year classes in 1991 and 1993, and a 99 percent decline between 1966 and 1991. NMFS reaffirmed the listing of Sacramento River winter-run Chinook salmon as endangered on June 28, 2005 (70

FR 37160). The ESU consists of only one population that is confined to the upper Sacramento River in California's Central Valley. The Livingston Stone National Fish Hatchery population has been included in the listed Sacramento River winter-run Chinook salmon ESU (June 28, 2005, 70 FR 37160). NMFS designated critical habitat for winter-run Chinook salmon on June 16, 1993 (58 FR 33212).

Sacramento River winter-run Chinook salmon adults enter the Sacramento River basin between December and July, the peak occurring in March (table 1; Yoshiyama *et al.* 1998, Moyle 2002). Spawning occurs primarily from mid-April to mid-August, with the peak activity occurring in May and June in the Sacramento River reach between Keswick Dam and RBDD (Vogel and Marine 1991). The majority of Sacramento River winter-run Chinook salmon spawners are 3 years old.

Emigration of juvenile Sacramento River winter-run Chinook salmon past RBDD may begin as early as mid July, typically peaks in September, and can continue through March in dry years (Vogel and Marine 1991). From 1995 to 1999, all Sacramento River winter-run Chinook salmon outmigrating as fry passed RBDD by October, and all outmigrating pre-smolts and smolts passed RBDD by March (Martin *et al.* 2001). Juvenile Sacramento River winter-run Chinook salmon occur in the Delta primarily from November through early May, based on data collected from trawls in the Sacramento River at West Sacramento [river mile (RM) 57, USFWS 2001]. The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type. Winter-run Chinook salmon juveniles remain in the Delta until they reach a fork length of approximately 118 millimeters (mm) and are from 5 to 10 months of age, and then begin emigrating to the ocean as early as November and continuing through May (Fisher 1994, Myers *et al.* 1998).

Historical Sacramento River winter-run Chinook salmon population estimates were as high as near 100,000 fish in the 1960s, but declined to under 200 fish in the 1990s (Good *et al.* 2005). In recent years, the carcass survey population estimates of winter-run Chinook salmon included in 8,218 in 2003, 7,869 in 2004, 15,839 in 2005, 17,334 in 2006 (CDFG 2008) show a recent increase in the population size and a 4-year average of 12,315. The 2006 run was the highest since the listing. However, the preliminary carcass count of winter-run Chinook salmon in 2007 was only 2,542 (CDFG 2008). The freshwater life history traits and habitat requirements of juvenile winter-run Chinook salmon and fall-run Chinook salmon are similar. Therefore, the unusual and poor ocean conditions that caused the drastic decline in returning fall run Chinook salmon populations coast wide in 2007 (Varanasi and Bartoo 2008) are suspected to have also caused the observed decrease in the winter-run Chinook salmon spawning population in 2007 (Oppenheim 2008). Two current methods are utilized to estimate the juvenile production of Sacramento River winter-run Chinook salmon: the Juvenile Production Estimate (JPE) method, and the Juvenile Production Index (JPI) method (Gaines and Poytress 2004). Gaines and Poytress (2004) estimated the juvenile population of Sacramento River winter-run Chinook salmon exiting the upper Sacramento River at RBDD to be 3,707,916 juveniles per year using the JPI method between the years 1995 and 2003 (excluding 2000 and 2001). Using the JPE method, Gaines and Poytress (2004) estimated an average of 3,857,036 juveniles exiting in the upper Sacramento River at RBDD between the years of 1996 and 2003. Averaging these 2 estimates yields an estimated population size of 3,782,476 juveniles during that time frame.

Based on RBDD counts, the population has been growing rapidly since the 1990s with positive short-term trends. An age-structured density-independent model of spawning escapement by Botsford and Brittnacher (1998) assessing the viability of Sacramento River winter-run Chinook salmon found the species was certain to fall below the quasi-extinction threshold of 3 consecutive spawning runs with fewer than 50 females (Good *et al.* 2005). Lindley and Mohr (2003) assessed the viability of the population using a Bayesian model based on spawning escapement that allowed for density dependence and a change in population growth rate in response to conservation measures. They found a biologically significant expected quasi-extinction probability of 28 percent. Although the status of the Sacramento River winter-run Chinook salmon population is improving, there is only one population, which depends on cold-water releases from Shasta Dam, and could be vulnerable to a prolonged drought (Good *et al.* 2005).

Lindley *et al.* (2007), in their framework for assessing the viability of Chinook salmon and steelhead in the Sacramento-San Joaquin River basin, concluded that the population of winter-run Chinook salmon that spawns below Keswick Dam satisfies low-risk criteria for population size and population decline, but increasing hatchery influence is a concern that puts the population at a moderate risk of extinction. Furthermore, Lindley *et al.* (2007) pointed out that an ESU represented by a single population at moderate risk is at a high risk of extinction over the long term.

b. Central Valley Spring-Run Chinook Salmon

NMFS listed the Central Valley spring-run Chinook salmon ESU as threatened on September 16, 1999 (64 FR 50394). In June 2004, NMFS proposed that Central Valley spring-run Chinook salmon remain listed as threatened (69 FR 33102). This proposal was based on the recognition that although Central Valley spring-run Chinook salmon productivity trends are positive, the ESU continues to face risks from having a limited number of remaining populations (*i.e.*, 3 existing populations from an estimated 17 historical populations), a limited geographic distribution, and potential hybridization with Feather River Hatchery (FRH) spring-run Chinook salmon, which until recently were not included in the ESU and are genetically divergent from other populations in Mill, Deer, and Butte Creeks. On June 28, 2005 (70 FR 37160), after reviewing the best available scientific and commercial information, NMFS issued its final rule to retain the status of Central Valley spring-run Chinook salmon as threatened. This decision also included the FRH spring-run Chinook salmon population as part of the Central Valley spring-run Chinook salmon ESU. Critical habitat was designated for Central Valley spring-run Chinook salmon on September 2, 2005 (70 FR 52488).

Adult Central Valley spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February (CDFG 1998) and enter the Sacramento River between March and September, primarily in May and June (table 2, Yoshiyama *et al.* 1998, Moyle 2002). Lindley *et al.* (2006a) indicated that adult Central Valley spring-run Chinook salmon enter native tributaries from the Sacramento River primarily between mid April and mid June. Typically, spring-run Chinook salmon utilize mid- to high-elevation streams that provide

appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering, while conserving energy and allowing their gonadal tissue to mature (Yoshiyama *et al.* 1998).

Table 1. The temporal occurrence of adult and juvenile Sacramento River winter-run Chinook salmon in the Sacramento River.

Adult Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River basin ¹												
Sacramento River ²												
Juvenile Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River at Red Bluff ³												
Sacramento River at Red Bluff ²												
Sacramento River at Knights Landing ⁴												
Lower Sacramento River (seine) ⁵												
West Sacramento River (trawl) ⁵												
Relative Abundance:	=High	=Medium	=Low									

Sources: ¹ Yoshiyama *et al.* (1998); Moyle (2002); ² Meyers *et al.* (1998); ³ Martin *et al.* (2001); ⁴ Snider and Titus (2000); ⁵ USFWS (2001)

Table 2. The temporal occurrence of adult and juvenile Central Valley spring-run Chinook salmon in the Sacramento River.

Adult Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River basin ^{1,2}												
Sacramento River ³												
Mill Creek ⁴												
Deer Creek ⁴												
Butte Creek ⁴												
Juvenile Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River Tributaries												
Upper Butte Creek												
Mill, Deer, Butte Creeks												
Sacramento River @ RBDD												
Sacramento River @ Knights Landing												
Relative Abundance:	=High	=Medium	=Low									

Sources: ¹ Yoshiyama *et al.* (1998); ² Moyle (2002); ³ Meyers *et al.* (1998); ⁴ Lindley *et al.* (2007); ⁵ CDFG (1998); ⁶ McReynolds *et al.* (2005); Ward *et al.* (2002, 2003); ⁷ Snider and Titus (2000)

Spring-run Chinook salmon fry emerge from the gravel from November to March (Moyle 2002), and the emigration timing is highly variable, as they may migrate downstream as young-of-the-year (YOY), juveniles, or yearlings. The modal size of fry migrants at approximately 40 mm between December and April in Mill, Butte, and Deer Creeks reflects a prolonged emergence of fry from the gravel (Lindley *et al.* 2006a). Studies in Butte Creek (Ward *et al.* 2002, 2003; McReynolds *et al.* 2005) found the majority of Central Valley spring-run Chinook salmon migrants to be fry occurring primarily during December through February, and that these movements appeared to be influenced by flow. Small numbers of Central Valley spring-run Chinook salmon remained in Butte Creek to rear and migrated as yearlings later in the spring. Juvenile emigration patterns in Mill and Deer Creeks are very similar to patterns observed in Butte Creek, with the exception that Mill and Deer Creek juveniles typically exhibit a later YOY migration and an earlier yearling migration (Lindley *et al.* 2006a).

Once juveniles emerge from the gravel, they seek areas of shallow water and low velocities while they finish absorbing the yolk sac (Moyle 2002). Many also will disperse downstream during high-flow events. As is the case of other salmonids, there is a shift in microhabitat use by juveniles to deeper, faster water as they grow. Microhabitat use can be influenced by the presence of predators, which can force fish to select areas of heavy cover and suppress foraging in open areas (Moyle 2002). Peak movement of juvenile Central Valley spring-run Chinook salmon in the Sacramento River at Knights Landing occurs in December, and again in March and April. However, juveniles also are observed between November and the end of May (Snider and Titus 2000).

On the Feather River, significant numbers of spring-run Chinook salmon, as identified by run timing, return to FRH. In 2002, FRH reported 4,189 returning spring-run Chinook salmon, which is 22 percent below the 10-year average of 4,727 fish. However, coded-wire tag (CWT) information from these hatchery returns indicates substantial introgression has occurred between fall-run and spring-run Chinook salmon populations within the Feather River system due to hatchery practices. Because Chinook salmon are not temporally separated in the hatchery, spring-run and fall-run Chinook salmon are spawned together, thus compromising the genetic integrity of the spring-run and early fall-run Chinook salmon stocks. The number of naturally-spawning spring-run Chinook salmon in the Feather River has been estimated only periodically since the 1960s, with estimates ranging from 2 fish in 1978 to 2,908 in 1964. However, the genetic integrity of this population is questionable because of the significant temporal and spatial overlap with fall-run Chinook salmon (Good *et al.* 2005). For the reasons discussed above, the Feather River spring-run Chinook population numbers are not included in the following discussion of ESU abundance.

The Central Valley spring-run Chinook salmon ESU has displayed broad fluctuations in adult abundance, ranging from 1,403 in 1993 to 25,890 in 1982. The average abundance for the ESU was 12,590 for the period of 1969 to 1979, 13,334 for the period of 1980 to 1990, 6,554 from 1991 to 2001, and 16,349 between 2002 and 2005 (Pacific Fishery Management Council 2004; CDFG 2004, 2006; Yoshiyama *et al.* 1998). Sacramento River tributary populations in Mill, Deer, and Butte Creeks are probably the best trend indicators for the Central Valley spring-run Chinook ESU as a whole because these streams contain the primary independent populations with the ESU. Generally, these streams have shown a positive escapement trend since 1991.

Escapement numbers are dominated by Butte Creek returns, which have averaged over 7,000 fish since 1995. During this same period, adult returns on Mill Creek have averaged 778 fish, and 1,463 fish on Deer Creek. Although recent trends are positive, annual abundance estimates display a high level of fluctuation, and the overall number of Central Valley spring-run Chinook salmon remains well below estimates of historic abundance. Additionally, in 2003, high water temperatures, high fish densities, and an outbreak of Columnaris Disease (*Flexibacter columnaris*) and Ichthyophthiriasis (*Ichthyophthirius multifiliis*) contributed to the pre-spawning mortality of an estimated 11,231 adult spring-run Chinook salmon in Butte Creek.

Lindley *et al.* (2006a) concluded that Butte and Deer Creek spring-run Chinook salmon are at low risk of extinction, satisfying viability criteria for population size, growth rate, hatchery influence, and catastrophe. The Mill Creek population is at a low to moderate risk, satisfying some, but not all viability criteria. The Feather and Yuba River populations are data deficient and were not assessed for viability. However, because the existing Central Valley spring-run Chinook salmon populations are spatially confined to relatively few remaining streams in only one of four historic diversity groups, the ESU remains vulnerable to catastrophic disturbance, and remains at a moderate to high risk of extinction.

2. Central Valley Steelhead

Central Valley steelhead were originally listed as threatened on March 19, 1998 (63 FR 13347). This DPS consists of steelhead populations in the Sacramento and San Joaquin River basins in California's Central Valley. In June 2004, NMFS proposed that Central Valley spring-run Chinook salmon remain listed as threatened (69 FR 33102). On June 28, 2005, after reviewing the best available scientific and commercial information, NMFS issued its final decision to retain the status of Central Valley steelhead as threatened (70 FR 37160). This decision also included the Coleman National Fish Hatchery and FRH steelhead populations. These populations were previously included in the DPS but were not deemed essential for conservation and thus not part of the listed steelhead population. Critical habitat was designated for Central Valley steelhead on September 2, 2005 (70 FR 52488).

Steelhead can be divided into two life history types, summer-run steelhead and winter-run steelhead, based on their state of sexual maturity at the time of river entry and the duration of their spawning migration, stream-maturing and ocean-maturing. Only winter steelhead are currently found in Central Valley rivers and streams (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the Sacramento river system prior to the commencement of large-scale dam construction in the 1940s [Interagency Ecological Program (IEP) Steelhead Project Work Team 1999]. At present, summer steelhead are found only in northern California coast drainages, mostly in tributaries of the Eel, Klamath, and Trinity River systems (McEwan and Jackson 1996).

Central Valley steelhead generally leave the ocean from August through April (Busby *et al.* 1996), and spawn from December through April, with peaks from January through March, in small streams and tributaries where cool, well oxygenated water is available year-round (table 3, Hallock *et al.* 1961, McEwan and Jackson 1996). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and associated lower water

temperatures. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapovalov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams.

Spawning occurs during winter and spring months. The length of time it takes for eggs to hatch depends mostly on water temperature. Hatching of steelhead eggs in hatcheries takes about 30 days at 51°F. Fry emerge from the gravel usually about 4 to 6 weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can speed or retard this time (Shapovalov and Taft 1954). Newly-emerged fry move to the shallow, protected areas associated with the stream margin (McEwan and Jackson 1996) and they soon move to other areas of the stream and establish feeding locations, which they defend (Shapovalov and Taft 1954).

Steelhead rearing during the summer takes place primarily in higher velocity areas in pools, although YOY also are abundant in glides and riffles. Productive steelhead habitat is characterized by complexity, primarily in the form of large and small woody debris. Cover is an important habitat component for juvenile steelhead both as velocity refugia and as a means of avoiding predation (Meehan and Bjornn 1991).

Juvenile steelhead emigrate episodically from natal streams during fall, winter, and spring high flows. Emigrating Central Valley steelhead use the lower reaches of the Sacramento River and the Delta for rearing and as a migration corridor to the ocean. Juvenile Central Valley steelhead feed mostly on drifting aquatic organisms and terrestrial insects and will also take active bottom invertebrates (Moyle 2002).

Some juvenile steelhead may utilize tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas in the Delta as rearing areas for short periods prior to their final emigration to the sea. Hallock *et al.* (1961) found that juvenile steelhead in the Sacramento River basin migrate downstream during most months of the year, but the peak period of emigration occurred in the spring, with a much smaller peak in the fall. Nobriga and Cadrett (2003) have also verified these temporal findings based on analysis of captures at Chipps Island, Suisun Bay.

Historic Central Valley steelhead run sizes are difficult to estimate given the paucity of data, but may have approached 1 to 2 million adults annually (McEwan 2001). By the early 1960s, the steelhead run size had declined to about 40,000 adults (McEwan 2001). Over the past 30 years, the naturally-spawned steelhead populations in the upper Sacramento River have declined substantially. Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River, upstream of the Feather River. Steelhead counts at RBDD declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations.

Recent estimates from trawling data in the Delta indicate that approximately 100,000 to 300,000 (mean 200,000) smolts emigrate to the ocean per year, representing approximately 3,600 female Central Valley steelhead spawners in the Central Valley basin (Good *et al.* 2005). This can be compared with McEwan's (2001) estimate of 1 million to 2 million spawners before 1850, and 40,000 spawners in the 1960s.

Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill Creeks and the Yuba River. Populations may exist in Big Chico and Butte Creeks, and a few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996). Recent snorkel surveys (1999 to 2002) indicate that steelhead are present in Clear Creek (Newton 2002 *op. cit.* Good *et al.* 2005). Because of the large resident *O. mykiss* population in Clear Creek, steelhead spawner abundance has not been estimated.

Until recently, Central Valley steelhead were thought to be extirpated from the San Joaquin River system. However, recent monitoring has detected small, self-sustaining populations of steelhead in the Stanislaus, Mokelumne, and Calaveras Rivers, and other streams previously thought to be devoid of steelhead (McEwan 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995 (S.P. Cramer and Associates Inc. 2000).

It is possible that naturally-spawning populations exist in many other streams but are undetected due to lack of monitoring programs (IEP Steelhead Project Work Team 1999). Incidental catches and observations of steelhead juveniles have also occurred on the Tuolumne and Merced Rivers during fall-run Chinook salmon monitoring activities, indicating that steelhead are widespread throughout accessible streams and rivers in the Central Valley (Good *et al.* 2005). CDFG staff have prepared juvenile migrant Central Valley steelhead catch summaries on the San Joaquin River near Mossdale, representing migrants from the Stanislaus, Tuolumne, and Merced Rivers. Based on trawl recoveries at Mossdale between 1988 and 2002, as well as rotary screw trap efforts in all three tributaries, CDFG (2003) stated that it is "clear from this data that rainbow trout do occur in all the tributaries as migrants and that the vast majority of them occur on the Stanislaus River." The documented returns on the order of single fish in these tributaries suggest that existing populations of Central Valley steelhead on the Tuolumne, Merced, and lower San Joaquin Rivers are severely depressed.

Lindley *et al.* (2006) indicated that prior population census estimates completed in the 1990s found the Central Valley steelhead spawning population above RBDD had a fairly strong negative population growth rate and small population size. Good *et al.* (2005) indicated the decline was continuing, as evidenced by new information (Chipps Island trawl data). Central Valley steelhead populations generally show a continuing decline, an overall low abundance, and fluctuating return rates. The future of Central Valley steelhead is uncertain due to limited data concerning their status. However, Lindley *et al.* (2007) concluded that there is sufficient evidence to suggest that the ESU is at moderate to high risk of extinction.

Table 3. The temporal occurrence of adult and juvenile Central Valley steelhead in the Central Valley.

Adult Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River basin ^{1,2}												
Sacramento River at Red Bluff ^{2,3}												
Mill, Deer Creeks ⁴												
Sacramento River at Fremont Weir ⁶												
San Joaquin River ⁷												
Juvenile Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River ^{1,2}												
Sacramento River at Knights Landing ^{2,8}												
Sacramento River at Knights Landing ⁹												
Chippis Island (wild) ¹⁰												
Mossdale ⁸												
Woodbridge Dam ¹¹												
Stanislaus River at Caswell ¹²												
Sacramento River at Hood ¹³												
Relative Abundance:	=High	=Medium	=Low									

Sources: ¹ Hallock (1961); ² McEwan (2001); ³ USFWS unpublished data; ⁴ CDFG (1995); ⁵ Hallock *et al.* (1957); ⁶ Bailey (1954); ⁷ CDFG Steelhead Report Card Data; ⁸ CDFG unpublished data; ⁹ Snider and Titus (2000); ¹⁰ Nobriga and Cadrett (2003); ¹¹ Jones & Stokes Associates, Inc. (2002); ¹² S.P. Cramer and Associates, Inc. (2000); ¹³ Schaffter (1980)

3. Southern DPS of North American Green Sturgeon

The Southern DPS of North American green sturgeon was listed as threatened on April 7, 2006, (70 FR 17386) and includes the North American green sturgeon population spawning in the Sacramento River and utilizing the Sacramento River, the Delta, and the San Francisco Estuary. North American green sturgeon are widely distributed along the Pacific Coast and have been documented offshore from Ensenada, Mexico, to the Bering Sea, and found in rivers from British Columbia to the Sacramento River (Moyle 2002). As is the case for most sturgeon, North American green sturgeon are anadromous; however, they are the most marine-oriented of the sturgeon species (Moyle 2002). In North America, spawning populations of the anadromous green sturgeon currently are found in only three river systems, the Sacramento and Klamath Rivers in California and the Rogue River in southern Oregon.

Two green sturgeon DPS', Northern and Southern, were identified based on evidence of spawning site fidelity (indicating multiple DPS tendencies), and on the preliminary genetic evidence that indicates differences at least between the Klamath River and San Pablo Bay samples (Adams *et al.* 2002). The Northern DPS includes all green sturgeon populations starting with the Eel River and extending northward. The Southern DPS would include all green sturgeon populations south of the Eel River,¹ with the only known spawning population being in the Sacramento River.

The Southern DPS of North American green sturgeon life cycle can be divided into four distinct phases based on developmental stage and habitat use: (1) adult females greater than or equal to 13 years of age and males greater than or equal to 9 years of age, (2) juveniles less than or equal to 3 years of age, (3) larvae and post-larvae less than 10 months of age, and (4) coastal migrant females between 3 and 13 years, and males between 3 and 9 years of age (Nakamoto *et al.* 1995, McLain 2006).

New information regarding the migration and habitat use of the Southern DPS of North American green sturgeon has emerged. Lindley (2006) presented preliminary results of large-scale green sturgeon migration studies, and verified past population structure delineations based on genetic work and found frequent large-scale migrations of green sturgeon along the Pacific Coast. It appears North American green sturgeon are migrating considerable distances up the Pacific Coast into other estuaries, particularly the Columbia Estuary. This information also agrees with the results of green sturgeon tagging studies (CDFG 2002), where CDFG tagged a total of 233 green sturgeon in the San Pablo Estuary between 1954 and 2001. A total of 17 tagged fish were recovered: 3 in the Sacramento-San Joaquin Estuary, 2 in the Pacific Ocean off of California, and 12 from commercial fisheries off of Oregon and Washington. Eight of the 12 recoveries were in the Columbia Estuary (CDFG 2002).

Kelley *et al.* (2006) indicated that green sturgeon enter the San Francisco Estuary during the spring and remain until autumn. They studied the movement of adults in the San Francisco

¹ Eel River is a major river system of California draining a rugged area in the California Coast Ranges between the Sacramento Valley and the ocean.

Estuary and found them to make significant long-distance movements with distinct directionality. The movements were not found to be related to salinity, current, or temperature, and Kelley *et al.* (2006) surmised they are related to resource availability. Green sturgeon were most often found at depths greater than 5 meters with low or no current during summer and autumn months (Erickson *et al.* 2002). The majority of green sturgeon in the Rogue River emigrated from freshwater habitat in December after water temperatures dropped (Erickson *et al.* 2002). They surmised that this holding in deep pools was to conserve energy and utilize abundant food resources. Based on captures of adult green sturgeon in holding pools on the Sacramento River above the Glen-Colusa Irrigation District (GCID) diversion (RM 205), the documented presence of adults in the Sacramento River during the spring and summer months, and the presence of larval green sturgeon in late summer in the lower Sacramento River indicating spawning occurrence, it appears adult green sturgeon could utilize a variety of freshwater and brackish habitats for up to 9 months of the year (Beamesderfer 2006).

Adult green sturgeon are believed to feed primarily upon benthic invertebrates such as clams, mysid and grass shrimp, and amphipods (Radtke 1966, Adams *et al.* 2002). Adult sturgeon caught in Washington State waters were found to have fed on Pacific sand lance (*Ammodytes hexapterus*) and callinassid shrimp (Moyle *et al.* 1992).

Based on the distribution of sturgeon eggs, larva, and juveniles in the Sacramento River, CDFG (2002) indicated that the Southern DPS of North American green sturgeon spawn in late spring and early summer above Hamilton City, possibly to Keswick Dam. Adult green sturgeon are believed to spawn every 3 to 5 years and reach sexual maturity only after several years of growth (*i.e.*, 10 to 15 years) based on sympatric white sturgeon sexual maturity (table 4, CDFG 2002). Adult female green sturgeon produce between 60,000 and 140,000 eggs each reproductive cycle, depending on body size, with a mean egg diameter of 4.3 mm (Moyle *et al.* 1992, Van Eenennaam *et al.* 2001). Adults of the Southern DPS of North American green sturgeon begin their upstream spawning migrations into San Francisco Bay in March, reach Knights Landing during April, and spawn between March and July (Heublein 2006). Peak spawning is believed to occur between April and June and thought to occur in deep turbulent pools (Adams *et al.* 2002). Substrate is likely large cobble, but can range from clean sand to bedrock (USFWS 2002). Newly hatched green sturgeon are approximately 12.5 to 14.5 mm in length. According to Heublein (2006), all adults leave the Sacramento River prior to September 1 of each year.

After approximately 10 days, larvae begin feeding, growing rapidly, and young green sturgeon appear to rear for the first 1 to 2 months in the Sacramento River between Keswick Dam and Hamilton City (CDFG 2002). Juvenile green sturgeon first appear in USFWS sampling efforts at RBDD in June and July at lengths ranging from 24 to 31 mm fork length (CDFG 2002, USFWS 2002). The mean yearly total length of post-larval green sturgeon captured in rotary screw traps at the RBDD ranged from 26 mm to 34 mm between 1995 and 2000, indicating they are approximately 2 weeks old. The mean yearly total length of post-larval green sturgeon captured in the GCID rotary screw trap, approximately 30 miles downstream of RBDD, ranged from 33 mm to 44 mm between 1997 and 2005 (CDFG, unpublished data) indicating they are approximately 3 weeks old (Van Eenennaam *et al.* 2001).

Green sturgeon larvae do not exhibit the initial pelagic swim-up behavior characteristic of other *Acipenseridae*. They are strongly oriented to the bottom and exhibit nocturnal activity patterns. Under laboratory conditions, green sturgeon larvae cling to the bottom during the day, and move into the water column at night (Van Eenennaam *et al.* 2001). After 6 days, the larvae exhibit nocturnal swim-up activity (Deng *et al.* 2002) and nocturnal downstream migrational movements (Kynard *et al.* 2005). Juvenile green sturgeon continue to exhibit nocturnal behavior beyond the metamorphosis from larvae to juvenile stages. Kynard *et al.*'s (2005) laboratory studies indicated that juvenile fish continued to migrate downstream at night for the first 6 months of life. When ambient water temperatures reached 46°F, downstream migrational behavior diminished and holding behavior increased. This data suggest that 9-to 10-month-old fish would hold over in their natal rivers during the ensuing winter following hatching, but at a location downstream of their spawning grounds. Juvenile green sturgeon have been salvaged at the Harvey O. Banks Pumping Plant and the John E. Skinner Fish Facility (Fish Facilities) in the South Delta, and captured in trawling studies by CDFG during all months of the year (CDFG 2002). The majority of these fish were between 200 and 500 mm indicating they were from 2 to 3 years of age based on Klamath River age distribution work by Nakamoto *et al.* (1995). The lack of a significant proportion of juveniles smaller than approximately 200 mm in Delta captures indicates juvenile of the Southern DPS of North American green sturgeon likely hold in the mainstem Sacramento River, as suggested by Kynard *et al.* (2005).

Population abundance information concerning the Southern DPS of North American green sturgeon is described in the NMFS status reviews (Adams *et al.* 2002, NMFS 2005a). Limited population abundance information comes from incidental captures of North American green sturgeon from the white sturgeon monitoring program by the CDFG sturgeon tagging program (CDFG 2002). By comparing ratios of white sturgeon to green sturgeon captures, CDFG provides estimates of adult and sub-adult North American green sturgeon abundance. Estimated abundance between 1954 and 2001 ranged from 175 fish to more than 8,000 per year and averaged 1,509 fish per year. Unfortunately, there are many biases and errors associated with these data, and CDFG does not consider these estimates reliable. Fish monitoring efforts at RBDD and GCID on the upper Sacramento River have captured between 0 and 2,068 juvenile North American green sturgeon per year (Adams *et al.* 2002). The only existing information regarding changes in the abundance of the Southern DPS of North American green sturgeon includes changes in abundance at the John E. Skinner Fish Facility between 1968 and 2001. The average number of the Southern DPS of North American green sturgeon taken per year at the State Facility prior to 1986 was 732; from 1986 on, the average per year was 47 (April 7, 2006, 70 FR 17386). For the Harvey O. Banks Pumping Plant, the average number prior to 1986 was 889; from 1986 to 2001 the average was 32 (April 7, 2006, 70 FR 17386). In light of the increased exports, particularly during the previous 10 years, it is clear that the abundance of the Southern DPS of North American green sturgeon is dropping. Additional analysis of North American green and white sturgeon taken at the Fish Facilities indicates that entrainment of both North American green and white sturgeon per acre-foot of water exported has decreased substantially since the 1960s (April 7, 2006, 70 FR 17386). Catches of sub-adult and adult North American green sturgeon by the IEP between 1996 and 2004 ranged from 1 to 212 green sturgeon per year (212 occurred in 2001); however, the portion of the Southern DPS of North American green sturgeon is unknown, as these captures were primarily located in San Pablo Bay, which is known to consist of a mixture of Northern and Southern DPS of North American green

Table 4. The temporal occurrence of adult, larval and post-larval, juvenile, and coastal migrant Southern DPS of North American green sturgeon.

Adult Location (≥13 yrs for females, ≥9 yrs for males)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Sac River ^{1, 2, 3}												
SF Bay Estuary ^{4, 8}												
Larval / Post-Larval Location (<10 mos)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RBDD, Sac River ⁵												
GCID, Sac River ⁵												
Juvenile Location (>10 mos and <3 yrs)												
South Delta ^{*6}												
Sac-SJ Delta ⁶												
Sac-SJ Delta ⁵												
Suisun Bay ⁵												
Coastal Migrant Location (3-13 yrs for females, 3-9 yrs for males)												
Pacific Coast ^{3, 7}												
Relative Abundance:												
	=High		=Medium		=Low							

Sources: ¹ USFWS (2002); ² Moyle *et al.* (1992); ³ Adams *et al.* (2002) and NMFS (NMFS 2005a); ⁴ Kelley *et al.* (2006); ⁵ CDFG (2002); ⁶ IEP Relational Database, fall midwater trawl green sturgeon captures from 1969 to 2003; ⁷ Nakamoto *et al.* (1995); ⁸ Heublein (2006) *Fish Facility salvage operations

sturgeon. Recent spawning population estimates using sibling-based genetics by Israel (2006) indicate a maximum spawning population of 32 spawners in 2002, 64 in 2003, 44 in 2004, 92 in 2005, and 124 in 2006 above RBDD (with an average of 71). Based on the length and estimated age of post-larvae captured at RBDD (approximately 2 weeks of age) and GCID (downstream; approximately 3 weeks of age), it appears the majority of the Southern DPS of North American green sturgeon are spawning above RBDD. Note, there are many assumptions with this interpretation (*i.e.*, equal sampling efficiency and distribution of post-larvae across channels) and this information should be considered cautiously. While green sturgeon populations were not analyzed in the recent salmonid population viability papers (Lindley *et al.* 2006, 2007) and NMFS' status reviews (Adams *et al.* 2002, NMFS 2005a), the information that is available on green sturgeon indicates that, as with Sacramento River winter-run Chinook salmon, the mainstem Sacramento River may be the last viable spawning habitat for the Southern DPS of North American green sturgeon (NMFS 2003). Lindley *et al.* (2007) pointed out that an ESU represented by a single population at moderate risk is at a high risk of extinction over the long term. Although the extinction risk of the Southern DPS of green sturgeon has not been assessed, NMFS believes that the extinction risk has increased because there is only one population, within the mainstem Sacramento River.

There are at least two records of confirmed adult sturgeon observation in the Feather River (Beamesderfer *et al.* 2004); however, there are no observations of juvenile or larval sturgeon even prior to the 1960s when Oroville Dam was built (NMFS 2005a). There are also unconfirmed reports that green sturgeon may spawn in the Feather River during high flow years (CDFG 2002).

Spawning in the San Joaquin River system has not been recorded, but alterations of the San Joaquin River tributaries (Stanislaus, Tuolumne, and Merced Rivers) and its mainstem occurred early in the European settlement of the region. During the later half of the 1800s, impassable barriers were built on these tributaries where the water courses left the foothills and entered the valley floor. Therefore, these low elevation dams have blocked potentially suitable spawning habitats located further upstream for over a century. Additional destruction of riparian and stream channel habitat by industrialized gold dredging further disturbed any valley floor habitat that was still available for sturgeon spawning. Both white and green sturgeon likely utilized the San Joaquin River basin for spawning prior to the onset of European influence, based on past use of the region by populations of Central Valley spring-run Chinook salmon and Central Valley steelhead. These two populations of salmonids have either been extirpated or greatly diminished in their use of the San Joaquin River basin over the past two centuries.

The freshwater habitat of North American green sturgeon in the Sacramento-San Joaquin drainage varies in function, depending on location. Spawning areas currently are limited to accessible upstream reaches of the Sacramento River. Preferred spawning habitats are thought to contain large cobble in deep, cool pools with turbulent water (CDFG 2002, Moyle 2002).

Migratory corridors are downstream of the spawning areas and include the mainstem Sacramento River and the Delta. These corridors allow the upstream passage of adults and the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams, unscreened or poorly screened diversions, and

degraded water quality. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their 1 to 3 year residence in freshwater. Rearing habitat condition and function may be affected by variation in annual and seasonal flow and temperature characteristics.

B. Critical Habitat and Primary Constituent Elements for Listed Salmonids

The designated critical habitat for Sacramento River winter-run Chinook salmon includes the Sacramento River from Keswick Dam (RM 302) to Chipps Island (RM 0) at the westward margin of the Delta; all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Estuary to the Golden Gate Bridge north of the San Francisco/Oakland Bay Bridge. In the Sacramento River, critical habitat includes the river water column, river bottom, and adjacent riparian zone used by fry and juveniles for rearing. In the areas westward of Chipps Island, critical habitat includes the estuarine water column and essential foraging habitat and food resources used by Sacramento River winter-run Chinook salmon as part of their juvenile emigration or adult spawning migration.

Critical habitat for Central Valley spring-run Chinook salmon includes stream reaches such as those of the Feather and Yuba Rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear Creeks, and the Sacramento River and Delta. Critical habitat for Central Valley steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope Creeks in the Sacramento River basin; and, the San Joaquin River its tributaries, and the Delta.

Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (September 2, 2005, 70 FR 52488). The bankfull elevation is defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series (Dunne and Leopold 1978, MacDonald *et al.* 1991, Rosgen 1996). Critical habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead is defined as specific areas that contain the primary constituent elements (PCE) and physical habitat elements essential to the conservation of the species. Following are the inland habitat types used as PCEs for Central Valley spring-run Chinook salmon and Central Valley steelhead, and as physical habitat elements for Sacramento River winter-run Chinook salmon.

1. Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most spawning habitat in the Central Valley for Chinook salmon and steelhead is located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation. Spawning habitat for Sacramento River winter-run Chinook salmon is restricted to the Sacramento River primarily

between RBDD and Keswick Dam. Central Valley spring-run Chinook salmon also spawn in the mainstem Sacramento River between RBDD and Keswick Dam and in tributaries such as Mill, Deer, and Butte Creeks. Spawning habitat for Central Valley steelhead is similar in nature to the requirements of Chinook salmon, primarily occurring in reaches directly below dams throughout the Central Valley. Most remaining natural spawning habitats (those not downstream from large dams) are currently in good condition, with adequate water temperatures, stream flows, and gravel conditions to support successful reproduction. Some areas below dams, especially for steelhead, are degraded by fluctuating flow conditions related to water storage and flood management that scour or strand redds. Regardless of its current condition, spawning habitat in general has a high intrinsic value, as its function directly affects the spawning success and reproductive potential of listed salmonids.

2. Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover, such as shade, submerged and overhanging large wood, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries may also be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system [*e.g.*, the lower Cosumnes River, Sacramento River reaches with set-back levees (*i.e.*, primarily located upstream of the City of Colusa)]. However, the channeled, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin River system typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Freshwater rearing habitat also has a high intrinsic value to salmonids, as the juvenile life stages are dependant on the function of this habitat for successful survival and recruitment. Thus, although much of the rearing habitat is in poor condition, it is important to the species.

3. Freshwater Migration Corridors

Ideal freshwater migration corridors are free of obstruction with water quantity and quality conditions and contain natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility, survival and food supply. Migratory corridors are downstream of the spawning area and include the lower Sacramento River and the Delta. These corridors allow the upstream passage of adults, and the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams, unscreened or poorly-screened diversions, and degraded water quality. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For adults, upstream passage through the Delta and much of the Sacramento River is not a problem, but problems exist on many tributary streams, and at the RBDD. For juveniles, unscreened or inadequately screen water diversions throughout their migration corridors and a

scarcity of complex in-river cover have degraded this PCE. However, since the primary migration corridors are used by numerous populations, and are essential for connecting early rearing habitat with the ocean, even the degraded reaches are considered to have a high intrinsic value to the species.

4. Estuarine Areas

Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water are included as a PCE. Natural cover, such as submerged and overhanging large wood, aquatic vegetation, and side channels, are suitable for juvenile and adult foraging. The remaining estuarine habitat for these species is severely degraded by altered hydrologic regimes, poor water quality, reductions in habitat complexity, and competition for food and space with exotic species. Regardless of the condition, the remaining estuarine areas are of high intrinsic value because they function as rearing habitat and as an area of transition to the ocean environment.

C. Factors Affecting Listed Species and Critical Habitat

1. Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon, Central Valley Steelhead

California's robust agricultural economy and rapidly increasing urban growth place high demand for water in the Sacramento and San Joaquin River basins. The demand for water in the Central Valley has significantly altered the natural morphology and hydrology of the Sacramento and San Joaquin Rivers and their major tributaries. Agricultural lands and urban areas have flourished on historic floodplains. An extensive flood management system of dams, levees, and bypass channels restricts the river's natural sinuosity, volume, and reduces the lag time of water flowing through the system. An impressive network of water delivery systems have transformed the Central Valley drainage system into a series of lined conveyance channels and reservoirs that are operated by several pumping facilities. Flood management and water delivery systems, in addition to agricultural, grazing, and urban land uses, are the main anthropogenic factors affecting watersheds in the action area.

A number of documents have addressed the history of human activities, present environmental conditions, and factors contributing to the decline of salmon and steelhead species in the Central Valley (*e.g.*, Busby *et al.* 1996, Myers *et al.* 1998, Good *et al.* 2005, CALFED 2000). NMFS has also assessed the factors contributing to Chinook salmon and steelhead decline in supplemental documents (NMFS 1996, 1998) and Federal Register notices (*e.g.*, June 16, 1993, 58 FR 33212; January 4, 1994, 59 FR 440; May 6, 1997, 62 FR 24588; August 18, 1997, 62 FR 43937; March 19, 1998, 63 FR 13347; May 5, 1999, 64 FR 24049; September 16, 1999, 64 FR 50394; February 16, 2000, 65 FR 7764). The foremost reason for the decline in these anadromous salmonid and green sturgeon populations is the degradation and/or destruction of habitat (*e.g.*, substrate, water quality, water quantity, water temperature, water velocity, shelter, food, riparian vegetation, and migration conditions). Additional factors contributing to the decline of these populations include: over-utilization, disease or predation, the inadequacy of existing regulatory mechanisms, and other natural and manmade factors including habitat and

ecosystem restoration, and global climate change. All of these factors have contributed to the ESA-listing of these fish and deterioration of their critical habitats. However, it is widely recognized in numerous species accounts in the peer-reviewed literature that the modification and curtailment of habitat and range have had the most substantial impacts on the abundance, distribution, population growth, and diversity of salmonid ESUs and DPSs. Although habitat and ecosystem restoration has contributed to recent improvements in habitat conditions throughout the ESUs/DPSs, global climate change remains a looming threat.

a. Modification and Curtailment of Habitat and Range

Modification and curtailment of habitat and range from hydropower, flood control, and consumptive water use have permanently blocked or hindered salmonid access to historical spawning and rearing grounds, resulting in the complete loss of substantial portions of spawning, rearing, and migration PCEs. Clark (1929) estimated that there were originally 6,000 linear miles of salmon habitat in the Central Valley system, and that 80 percent of this habitat had been lost by 1928. Yoshiyama *et al.* (1996) calculated that roughly 2,000 linear miles of salmon habitat was actually available before dam construction and mining, and concluded that 82 percent is not accessible today. Yoshiyama *et al.* (1996) surmised that steelhead habitat loss was even greater than salmon loss, as steelhead migrated farther into drainages. In general, large dams on every major tributary to the Sacramento River, San Joaquin River, and the Delta block salmon and steelhead access to the upper portions of their respective watersheds. The loss of upstream habitat had required Chinook salmon and steelhead to use less hospitable reaches below dams. The loss of substantial habitat above dams also has resulted in decreased juvenile and adult steelhead survival during migration, and in many cases, had resulted in the dewatering and loss of important spawning and rearing habitats.

The diversion and storage of natural flows by dams and diversion structures on Central Valley waterways have depleted stream flows and altered the natural cycles by which juvenile and adult salmonids have evolved. Changes in stream flows and diversions of water affect spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine habitat PCEs. As much as 60 percent of the natural historical inflow to Central Valley watersheds and the Delta have been diverted for human uses. Depleted flows have contributed to higher temperatures, lower dissolved oxygen (DO) levels, and decreased recruitment of gravel and instream woody material. More uniform flows year-round have resulted in diminished natural channel formation, altered food web processes, and slower regeneration of riparian vegetation. These stable flow patterns have reduced bedload movement, caused spawning gravels to become embedded, and decreased channel widths due to channel incision, all of which has decreased the available spawning and rearing habitat below dams.

Water withdrawals, for agricultural and municipal purposes have reduced river flows and increased temperatures during the critical summer months, and in some cases, have been of a sufficient magnitude to result in reverse flows in the lower San Joaquin River (Reynolds *et al.* 1993). Direct relationships exist between water temperature, water flow, and juvenile salmonid survival (Brandes and McLain 2001). High water temperatures in the Sacramento River have limited the survival of young salmon.

The development of the water conveyance system in the Delta has resulted in the construction of more than 1,100 miles of channels and diversions to increase channel elevations and flow capacity of the channels (Mount 1995). Levee development in the Central Valley affects spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine habitat PCEs. The construction of levees disrupts the natural processes of the river, resulting in a multitude of habitat-related effects that have diminished conditions for adult and juvenile migration and survival.

Many of these levees use angular rock (riprap) to armor the bank from erosive forces. The effects of channelization and riprapping include the alteration of river hydraulics and cover along the bank as a result of changes in bank configuration and structural features (Stillwater Sciences 2006). These changes affect the quantity and quality of nearshore habitat for juvenile salmonids and have been thoroughly studied (USFWS 2000, Schmetterling *et al.* 2001, Garland *et al.* 2002). Simple slopes protected with rock revetment generally create nearshore hydraulic conditions characterized by greater depths and faster, more homogeneous water velocities than occur along natural banks. Higher water velocities typically inhibit deposition and retention of sediment and woody debris. These changes generally reduce the range of habitat conditions typically found along natural shorelines, especially by eliminating the shallow, slow-velocity river margins used by juvenile fish as refuge and escape from fast currents, deep water, and predators (Stillwater Sciences 2006).

Large quantities of downed trees are a functionally important component of many streams (NMFS 1996). Large woody debris influences channel morphology by affecting longitudinal profile, pool formation, channel pattern and position, and channel geometry. Downstream transport rates of sediment and organic matter are controlled in part by storage of this material behind large wood. Large wood affects the formation and distribution of habitat units, provides cover and complexity, and acts as a substrate for biological activity (NMFS 1996). Wood enters streams inhabited by salmonids either directly from adjacent riparian zones or from riparian zones in adjacent non-fish bearing tributaries. Removal of riparian vegetation and instream woody material from the streambank results in the loss of a primary source of overhead and instream cover for juvenile salmonids. The removal of riparian vegetation and instream woody material and the replacement of natural bank substrates with rock revetment can adversely affect important ecosystem functions. Living space and food for terrestrial and aquatic invertebrates is lost, eliminating an important food source for juvenile salmonids. Loss of riparian vegetation and soft substrates reduces inputs of organic material to the stream ecosystem in the form of leaves, detritus, and woody debris, which can affect biological production at all trophic levels.

In addition, the armoring and revetment of stream banks tends to narrow rivers, reducing the amount of habitat per unit channel length (Sweeney *et al.* 2004). As a result of river narrowing, benthic habitat decreases and the number of macroinvertebrates, such as stoneflies and mayflies, per unit channel length decreases affecting salmonid food supply.

b. Ecosystem Restoration

The Central Valley “practicably irrigable acreage” (PIA), implemented in 1992, requires that fish and wildlife get equal consideration with other demands for water allocations derived from the

Central Valley PIA. From this act arose several programs that have benefited listed salmonids: the Anadromous Fish Restoration Program (AFRP), the Anadromous Fish Screen Program (AFSP), and the Water Acquisition Program (WAP). The AFRP is engaged in monitoring, education, and restoration projects geared toward doubling the natural populations of select anadromous fish species residing in the Central Valley. Restoration projects funded through the AFRP include fish passage, fish screening, riparian easement and land acquisition, development of watershed planning groups, instream and riparian habitat improvement, and gravel replenishment. The AFSP combines Federal funding with State and private funds to prioritize and construct fish screens on major water diversions mainly in the upper Sacramento River. The goal of the WAP is to acquire water supplies to meet the habitat restoration and enhancement goals of the Central Valley PIA and to improve the Department of the Interior's ability to meet regulatory water quality requirements. Water has been used successfully to improve fish habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead by maintaining or increasing instream flows in Butte and Mill Creeks and the San Joaquin River at critical times.

Two programs included under CALFED; the Ecosystem Restoration Program (ERP) and the Environmental Water Account, were created to improve conditions for fish, including listed salmonids, in the Central Valley. Restoration actions implemented by the ERP include the installation of fish screens, modification of barriers to improve fish passage, habitat acquisition, and instream habitat restoration. The majority of these actions address key factors affecting listed salmonids, and emphasis has been placed in tributary drainages with high potential for Central Valley steelhead and spring-run Chinook salmon production. Additional ongoing actions include new efforts to enhance fisheries monitoring and directly support salmonid production through hatchery releases. Recent habitat restoration initiatives sponsored and funded primarily by the CALFED-ERP have resulted in plans to restore ecological function to 9,543 acres of shallow-water tidal and marsh habitats within the Delta. Restoration of these areas primarily involves flooding lands previously used for agriculture, thereby creating additional rearing habitat for juvenile salmonids.

The California Department of Water Resources' (CDWR) Four Pumps Agreement Program has approved approximately \$49 million for projects that benefit salmon and steelhead production in the Sacramento-San Joaquin basins and Delta since the agreement's inception in 1986. Four Pumps projects that benefit Central Valley spring-run Chinook salmon and steelhead include water exchange programs on Mill and Deer Creeks; enhanced law enforcement efforts from San Francisco Estuary upstream to the Sacramento and San Joaquin Rivers and their tributaries; design and construction of fish screens and ladders on Butte Creek; and screening of diversions in Suisun Marsh and San Joaquin tributaries. Additionally, predator habitat isolation and removal and spawning habitat enhancement projects on the San Joaquin tributaries benefit steelhead.

c. Natural Conditions/Climate Change

Natural changes in the freshwater and marine environments play a major role in salmonid and green sturgeon abundance. Recent evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Hare *et al.* 1999, Mantua and Hare 2002). This phenomenon has been referred to as the Pacific

Decadal Oscillation. In addition, large-scale climatic regime shifts, such as El Niño, appear to change ocean productivity. During the first part of the 1990s, much of the Pacific Coast was subject to a series of very dry years.

The world is about 1.3°F warmer today than a century ago and the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century (Intergovernmental Panel on Climate Change 2001). Much of that increase will likely occur in the oceans, and evidence suggests that the most dramatic changes in ocean temperature are now occurring in the Pacific (Noakes 1998). Using objectively analyzed data, Huang and Liu (2000) estimated a warming of about 0.9°F per century in the Northern Pacific Ocean.

An alarming prediction is the fact that Sierra snow packs are expected to decrease with global warming and that the majority of runoff in California will be from rainfall in the winter rather than from melting snow pack in the mountains (CDWR 2006). This will alter river runoff patterns and transform the tributaries that feed the Central Valley from a spring/summer snowmelt-dominated system to a winter rain dominated system. This would likely truncate the period of time that suitable cold-water conditions exist below existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold-water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall temperatures below reservoirs, such as Lake Shasta, could rise above thermal tolerances for juvenile and adult salmonids (*e.g.*, Sacramento River winter-run Chinook salmon and Central Valley steelhead) that must hold below Keswick Dam over the summer and fall periods.

Another key factor affecting many West Coast fish stocks has been a general 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood, partially because the pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. NMFS presumes that survival is driven largely by events occurring between ocean entry and recruitment to a subadult life stage. One indicator of early ocean survival can be computed as a ratio of CWT recoveries from subadults relative to the number of CWTs released from that brood year.

Salmon and steelhead are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Ocean predation may also contribute to significant natural mortality, although to what degree is not known. In general, salmonids are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that the rebound of seal and sea lion populations—following their protection under the Marine Mammal Protection Act of 1972—has substantially increased salmonid mortality.

Finally, the unusual drought conditions in 2001 warrant additional consideration. Flows in 2001 were among the lowest flow conditions on record. The available water in the Sacramento and San Joaquin River watersheds was 70 percent and 66 percent of normal, according to the Sacramento River Index and the San Joaquin River Index, respectively. The juveniles that

passed downriver during the 2001 spring and summer out migration were likely affected, and this, in turn, likely affected adult returns primarily in 2003 and 2004, depending on the stock and species.

d. Southern DPS of North American Green Sturgeon

The principal factors for the decline in the Southern DPS of North American green sturgeon are reviewed in the proposed listing notice (April 6, 2005, 70 FR 17386) and status reviews (Adams *et al.* 2002, NMFS 2005a), and primarily consist of: (1) the present or threatened destruction, modification, or curtailment of habitat or range; (2) poor water quality; (3) over-utilization; (4) increased water temperatures; (5) non-native species; and (6) other natural and manmade factors, including habitat and ecosystem restoration, and global climate change.

NMFS (2005a) concluded that the principle threat to green sturgeon is impassible barriers, primarily Keswick and Shasta Dams on the Sacramento River and Feather River that likely block and prevent access to historic spawning habitat (NMFS 2005a). Spawning habitat may have extended up into the three major branches of the Sacramento River; the Little Sacramento River, the Pit River system, and the McCloud River (NMFS 2005a). In contrast, recent modeling evaluations by Mora (2006) indicate little or no habitat in the Little Sacramento River or the Pit River exists above Shasta Dam; however, a considerable amount of habitat exists above Shasta on the mainstem Sacramento River. Green and white sturgeon adults have been observed periodically in the Feather and Yuba Rivers (USFWS 1995, Beamesderfer *et al.* 2004, McLain 2006), and habitat modeling by Mora (2006) suggests there is sufficient habitat above Oroville Dam. There are no records of larval or juvenile white or green sturgeon; however, there are reports that green sturgeon may reproduce in the Feather River during high flow years (CDFG 2002), but these are unconfirmed.

No green sturgeon have been observed in the San Joaquin River; however, the presence of white sturgeon has been documented (USFWS 1995, Beamesderfer *et al.* 2004), making green sturgeon presence historically likely, as the two species require similar habitat and their ranges overlap in the Sacramento River. Habitat modeling by Mora (2006) also suggests sufficient conditions are present in the San Joaquin River to Friant Dam, and in the Stanislaus, Tuolumne, and Merced Rivers to their respective dams. In addition, the San Joaquin River had the largest spring-run Chinook salmon population in the Central Valley prior to the construction of Friant Dam (Yoshiyama *et al.* 2001) with escapements approaching 500,000 fish. Thus, based on prior spring-run Chinook salmon distribution and habitat use in the San Joaquin River, it is very possible that green sturgeon were extirpated from the San Joaquin River basin in a similar manner to spring-run Chinook salmon. The loss of potential green sturgeon spawning habitat on the San Joaquin River also may have contributed to the overall decline of the Southern DPS of North American green sturgeon.

The potential effects of climate change were discussed in the Chinook salmon and Central Valley steelhead sections and primarily consist of altered ocean temperatures and stream flow patterns in the Central Valley. Changes in Pacific Ocean temperatures can alter predator-prey relationships and affect migratory habitat of the Southern DPS of North American green sturgeon. Increases in rainfall and decreases in snow pack in the Sierra Nevada range will affect

cold-water pool storage in reservoirs affecting river temperatures. As a result, the quantity and quality of water that may be available to the Southern DPS of North American green sturgeon will likely significantly decrease.

e. Critical Habitat for Salmonids

According to NMFS' (2005b) Critical Habitat Analytical Review Team (CHART) report, the major categories of habitat-related activities affecting Central Valley salmonids include: (1) irrigation impoundments and withdrawals, (2) channel modifications and levee maintenance, (3) the presence and operation of hydroelectric dams, (4) flood control and streambank stabilization, and (5) exotic and invasive species introductions and management. All of these activities affect PCEs via their alteration of one or more of the following: stream hydrology, flow and water-level modification, fish passage, geomorphology and sediment transport, temperature, DO levels, nearshore and aquatic vegetation, soils and nutrients, physical habitat structure and complexity, forage, and predation (Spence *et al.* 1996). According to the CHART report (NMFS 2005b), the condition of critical habitat varies throughout the range of the species. Generally, the conservation value of existing spawning habitat ranges from moderate to high quality, with the primary threats including changes to water quality, and spawning gravel composition from rural, suburban, and urban development, forestry, and road construction and maintenance. Downstream, river and estuarine migration and rearing corridors range in condition from poor to high quality depending on location. Tributary migratory and rearing corridors tended to rate as moderate quality due to threats to adult and juvenile life stages from irrigation diversion, small dams, and water quality. Delta (*i.e.*, estuarine) and mainstem Sacramento and San Joaquin River reaches tended to range from poor to high quality, depending on location. In the alluvial reach of the Sacramento River between Red Bluff and Colusa, the PCEs of rearing and migration habitat are in good condition because, despite the influence of upstream dams, this reach retains natural, and functional channel processes that maintain and develop anadromous fish habitat. The river reach downstream from Colusa and including the Delta is poor in quality due to impaired hydrologic conditions from dam operations, water quality from agriculture, degraded nearshore and riparian habitat from levee construction and maintenance, and habitat loss and fragmentation.

IV. ENVIRONMENTAL BASELINE

The environmental baseline "includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation process" (50 CFR 402.02). As stated in section II.D, "Action Area," of this biological opinion, the action area encompasses: (1) the lateral 200 feet of the Sacramento River beginning at the right bank, from 200 feet upstream of the Mill Site construction area to 500 feet downstream of RBDD. This area was selected because it represents the upstream and lateral extents of anticipated acoustic effects from pile driving, and downstream extent of anticipated effects related to increases in suspended sediment and turbidity. The length of this reach is relatively short and totals approximately 3,750 feet; and (2) Red Bank Creek, from the proposed

location of the bridge, downstream approximately 600 feet to the confluence of the Sacramento River.

1. Status of Listed Species and Critical Habitat within the Action Area

The action area provides adult spawning and juvenile rearing habitat, and functions as a migratory corridor for adult and juvenile winter- and spring-run Chinook salmon, Central Valley steelhead, and Southern DPS of North American green sturgeon. Due to the life history timing of winter- and spring-run Chinook salmon, steelhead and North American green sturgeon, it is possible for one or more of the following life stages to be present within the action area throughout the year: adult migrants, spawners, incubating eggs, or rearing and emigrating juveniles.

a. Status of the Species in the Action Area

(1) Chinook Salmon. CDFG conducts frequent aerial redd surveys of the upper Sacramento River from Princeton Ferry to Keswick Dam throughout the year. Records were examined for the reaches extending from RBDD upstream to Bend Bridge, and from RBDD downstream to the Tehama Bridge, for the period from 2001 through 2007. These surveys indicate that the action area is within the spawning range of winter- and spring-run Chinook salmon, however, they suggest that limited spawning occurs within the action area. Most spring-run Chinook salmon, including all 3 independent populations, spawn downstream of the action area and will not be affected by the proposed project. Although the CDFG surveys are not of sufficient precision or uniform frequency to allow accurate quantification of the number of redds historically observed in the immediate vicinity of RBDD, the following general statements can be made. Most redds were present between October 1 and December 31, indicating that they were most likely created by fall-run and late fall-run Chinook salmon (non-listed species). A total of 3,546 redds were recorded in the combined reaches upstream and downstream of RBDD; of these, less than 1 percent (29) were built during the time period when winter-run Chinook salmon would be expected to be spawning, or the period exclusive to spring-run spawning (September). Most spawning in the action area occurs just downstream of RBDD. The gravel bar located at the mouth of Red Bank Creek just upstream of RBDD is also a likely spawning area during periods when the RBDD gates are open (Tucker 2007). Current operation of RBDD results in the presence of Lake Red Bluff extending upstream from RBDD during the period from May 15 through September 15, which would preclude most spawning in this portion of the action area by winter- and spring- run Chinook salmon.

(2) Central Valley Steelhead. Central Valley steelhead populations currently spawn in tributaries to the Sacramento and San Joaquin Rivers. The proportion of steelhead in this DPS that migrate through the action area is unknown. However, because of the relatively large amount of suitable habitat in the Sacramento River relative to the San Joaquin River, the proportion is probably high. Adult steelhead may be present throughout the action area from June through March, with the peak occurring between August and October (Bailey 1954, Hallock *et al.* 1957). Juvenile steelhead emigrate through the Sacramento River from late fall to spring. Snider and Titus (2000) observed that juvenile steelhead emigration primarily occurs between November and May at Knights Landing. The majority of juvenile steelhead emigrate as

yearlings and are assumed to primarily utilize the center of the channel rather than the shoreline. Central Valley steelhead and/or rainbow trout redds have been observed within the action area during aerial redd surveys, although these redds have not been counted or documented (Killam 2005).

(3) *Southern DPS of North American Green Sturgeon.* The spawning population of the Southern DPS of North American green sturgeon is currently restricted to the Sacramento River below Keswick Dam, and is composed of a single breeding population, thus the entire population of adults and juveniles must pass through the action area. Adult green sturgeon were video documented immediately below RBDD in 2004 (Killam 2005). During the period of an emergency RBDD gate closure from May 3-9, 2007, adult green sturgeon were observed staging (*i.e.*, for upstream migration) on the downstream side of the dam (Corwin 2007). Newly hatched juvenile green sturgeon are captured each summer in the rotary screw traps which sample the water coming out of RBDD (Gaines and Martin 2002) providing firm evidence that spawning occurs upstream of RBDD.

b. Status of Critical Habitat in the Action Area

(1) *Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon, and Central Valley Steelhead.* The action area is within designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon and Central Valley steelhead. Habitat requirements for these species are similar. The PCEs of salmonid habitat within the action area include: freshwater rearing habitat and freshwater migration corridors, containing adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food; riparian vegetation, space, and safe passage conditions. Habitat within the action area is primarily used as adult and juvenile migration and juvenile rearing. The condition and function of this habitat has been severely impaired through several factors discussed in section III.C, “Factors Affecting Listed Species and Critical Habitat,” of this biological opinion. The result has been the reduction in quantity and quality of several essential elements of migration and rearing habitat required by juveniles to grow and survive. In spite of the degraded condition of this habitat, it remains extremely important to the survival of the listed salmonids because its entire length is used for extended periods of time by a large proportion of all Federally-listed anadromous fish species that spawn in the upper Sacramento River and its tributaries above RBDD.

The greatest impacts to the PCEs of critical habitat within the action area are related to the construction and operation of RBDD and its associated diversion facilities. Large amounts of concrete and sheet piling dominate the habitat features within the action area. The dam and diversion complex impact the PCEs of spawning (through inundation of potential spawning habitat upstream of the dam), migration (through blockage of upstream migrants and entrainment of downstream migrants), and rearing (by reducing the complexity of near-shore habitats and creating unnatural advantages to piscivorous predators around the manmade structures).

The river bank and riparian zone along the Mill Site has also been heavily impacted by RBDD operations. Frequent inundation and draining of the area caused by lowering and raising of the RBDD gates has left much of this shoreline nearly devoid of vegetation. During gates-out (free

flowing) conditions, this shoreline consists of a nearly vertical 10- to 20-foot tall adobe clay bank with little or no vegetation near the water's edge. When the RBDD gates are lowered and the lake is formed (and during high winter flow events), the water level rises to a point where the sparse riparian vegetation along the top of the bank may have some contact with, and provide some shading to, the water line.

The diversion and storage of natural flows by dams and diversion structures on Central Valley waterways have depleted streamflows and altered the natural cycles by which juvenile and adult salmonids have evolved. Changes in streamflows and diversions of water affect freshwater rearing habitat and freshwater migration corridor PCEs in the action area. Various land-use activities in the action area, such as urbanization and agricultural encroachment, have resulted in habitat simplification. Runoff from residential and industrial areas also contributes to water quality degradation [California Regional Water Quality Control Board (CRWQCB)-Central Valley Region 1998]. Urban stormwater runoff contains pesticides, oil, grease, heavy metals, polycyclic aromatic hydrocarbons, other organics and nutrients (CRWQCB-Central Valley Region 1998) that contaminate drainage waters and destroy aquatic life necessary for salmonid survival (NMFS 1996). In addition, juvenile salmonids are exposed to increased water temperatures as a result of thermal inputs from municipal, industrial, and agricultural discharges in the action area. Increased predation as a result of habitat changes in the action area, such as the alteration of natural flow regimes and the installation of bank revetment structures, is likely a factor in the decline of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead.

Within the action area, the freshwater rearing and migration PCEs have been transformed from a meandering waterway lined with a dense riparian corridor, to a highly leveed system under varying degrees of control over riverine erosional processes and flooding.

(2) Southern DPS of North American Green Sturgeon. The majority of the action area is utilized by the Southern DPS of North American green sturgeon adults for holding and migration. North American green sturgeon holding habitat consists of the bottoms of deep pools where velocities are lowest, often in off-channel coves or low-gradient reaches of the main channel (Erickson *et al.* 2002). Erickson *et al.* (2002) also found many of these sites were close to sharp bends in the Rogue River.

The diversions in the action area are a potential threat to the Southern DPS of North American green sturgeon. Larval green sturgeon are likely susceptible to entrainment primarily from benthic water diversion facilities during the first 5 days of development and susceptible to diversion entrainment from facilities drawing water from the bottom and top of the water column starting at day 6. Reduced flows in the action area likely affect year class strength of the Southern DPS of North American green sturgeon as increased flows have been found to improve year class strength. Various land-use activities in the action area, such as urbanization and agricultural encroachment, have resulted in habitat simplification. Runoff from residential and industrial areas also contributes to water quality degradation (CRWQCB-Central Valley Region 1998). Urban stormwater runoff contains pesticides, oil, grease, heavy metals, polycyclic aromatic hydrocarbons, other organics and nutrients (CRWQCB-Central Valley Region 1998) that contaminate drainage waters and destroy aquatic life necessary for green sturgeon survival

(NMFS 1996). In addition, juvenile and adult green sturgeon are exposed to increased water temperatures as a result of thermal inputs from municipal, industrial, and agricultural discharges in the action area.

The transformation of the Sacramento River from a meandering waterway lined with dense riparian corridor, to a highly leveed system under varying degrees of control over riverine erosional processes resulted in homogenization of the river, including effects to the river's sinuosity (USFWS 2000). In addition, the change in the ecosystem as a result of the removal of riparian vegetation and instream woody material likely impacted potential prey items and species interaction that green sturgeon would experience while holding. The effects of channelization on upstream migration of green sturgeon are unknown.

The action area is utilized by larvae and post-larvae and to a lesser extent, juvenile Southern DPS of North American green sturgeon for rearing and migration purposes. Although it is believed that larvae and post-larvae as well as juveniles primarily are benthically oriented (with the exception of the post-larvae nocturnal swim-up believed to be a dispersal mechanism), channelization in the action area has resulted in a loss of ecosystem properties (USFWS 2000, Sweeney *et al.* 2004). Channelization results in reduced food supply (aquatic invertebrates) and reduced pollutant processing, organic matter processing, and nitrogen uptake (Sweeney *et al.* 2004).

2. Factors Affecting Listed Species and Critical Habitat within the Action Area

Current operation of RBDD under the OCAP biological opinion (NMFS 2004) includes a 4-month period (mid-May through mid-September) when the dam gates are placed in the river. During gates-in periods, juvenile life stages of all anadromous salmonids migrate downstream (emigrate) past RBDD under the dam gates, through the fish ladders and their auxiliary water systems, or are subjected to entrainment and passage through diversion bypass systems at the RPP and TCC headworks. The most significant threat to the juvenile salmonids passing through the action area are the direct losses related to passing under the RBDD gates and subsequent predation by Sacramento River pikeminnows and striped bass that congregate immediately below the dam. Additionally, predation by avian and fish species within Lake Red Bluff might be a significant threat to all juvenile life stages in the vicinity of RBDD. When the gates are in the river, velocity barriers and whitewater turbulence are created that prevent adult Chinook salmon and steelhead from passing upstream of the dam, except through fish ladders located on the east and west ends and at the center of RBDD. These ladders are undersized and are not very successful in passing adult salmonids without delays.

Under current operations, approximately 15 percent of winter-run Chinook salmon adult spawners passing through the action area might be blocked or delayed by the current 4-month period when the dam gates are in operation. Adult Central Valley spring-run Chinook salmon are also significantly affected by RBDD operations. Approximately 10 percent of adult spring-run Chinook salmon spawn upstream of RBDD. Of those, approximately 75 percent pass through the action area during the current gates-in operation. Impedance of these adult spring-run Chinook salmon by RBDD operations might adversely affect their ability to successfully migrate into tributary stream and headwater reaches upstream of RBDD. It is challenging to

characterize the temporal distribution of adult winter- and spring-run Chinook salmon as they pass RBDD because before mid-May, the gates-out operations at RBDD preclude the use of the fish ladders and, therefore, the enumeration of adults as they pass RBDD. However, after the RBDD gates go in during May, Chinook salmon are identified as they pass. Up to 25 percent of the annual run of adult Central Valley fall-run Chinook salmon might be affected by the current gates-in operation (CH2MHill 2007). Currently, adult late-fall-run Chinook salmon pass unimpeded at RBDD because they immigrate during the period (October through March) when the RBDD gates are out of the river.

For migrating adult steelhead, approximately 17 percent of the annual adult steelhead run might be affected by the current gates-in operation. Approximately 36 percent of juvenile steelhead passing RBDD are subject to operational impacts during the gates-in period.

When the dam gates are placed in the river, a physical barrier is created that prevents passage of adult sturgeon, as green sturgeon are not known to successfully use the fish ladders at RBDD (Brown 2002). Currently, a large portion of the adult green sturgeon successfully pass RBDD unimpeded because they are immigrating during the period before May 15 when the gates go in. Under current operations, approximately 35 percent of adult green sturgeon spawners passing through the action area might be blocked by RBDD. In addition, some adult green sturgeon might be delayed in their down-river migration by RBDD after spawning occurs upstream of the dam before May 15 if these fish arrive at RBDD on or after May 16 when the dam gates are placed in the river. With the current gates-in operations, approximately 99 percent of annual green sturgeon larvae/post-larvae passing RBDD are subjected to the operational effects of the dam and its associated diversion facilities.

Ongoing improvements to the upper reaches of the Sacramento River, including gravel augmentation, screening of diversions, and riparian habitat restoration, are expected to further improve conditions for anadromous fish and critical habitat, but the incremental benefit of these actions is not yet known. Even with these improvements, some problems persist that may affect anadromous fish and reduce the quality of the PCEs of critical habitat within the action area. Some of the remaining problems include episodic discharges of heavy metals from the Iron Mountain Mine Superfund site, major fall and winter flow reductions causing dewatering of redds, potential competition and genetic introgression between spring- and fall-run Chinook salmon due to overlapping spawning habitats, and degraded rearing conditions in the river due to a lack of mature riparian habitat.

The frequency of acid mine drainage exceeding target levels below Keswick Dam has decreased over the last 10 years; however, exceedences of dissolved copper targets have occurred during each of the last 6 years, and metal concentrations remain high enough to have sublethal effects on adult fish and lethal effects on eggs and larvae (CRWQCB 2001). Although acid mine drainage has, over the years, reduced the number of Chinook salmon and steelhead within the action area, recent remedial actions at Iron Mountain Mine are thought to have curtailed the direct poisoning of listed species.

Fall flow reductions have been found to negatively impact PCEs for salmonid spawning by causing extensive redd dewatering throughout the Sacramento River spawning areas (Killam

2002). The largest reductions have been occurring in early to mid-November, following the peak in water demand for rice decomposition. While reductions in this time period primarily impact fall-run Chinook salmon, they also have the potential to impact late spawning spring-run Chinook salmon and early spawning steelhead.

The construction of Shasta and Keswick Dams, and the resultant exclusion of spring-run Chinook salmon from their historic upper Sacramento River spawning habitat has forced mainstem-spawning spring-run Chinook salmon to spawn in the middle reaches of the river (between Keswick and Red Bluff Dams) in areas easily accessible to fall-run Chinook salmon. Because spring-run Chinook salmon hold over the summer and spawn during a similar time period as do fall-run Chinook salmon (September through October depending on habitat conditions), there is a potential for the two species to have negative interactions such as competition for prime spawning sites, superimposition of redds in the same location, and genetic introgression caused by individuals of the different races spawning together and creating crossed progeny.

3. Importance of the Action Area to the Survival and Recovery of Listed Species

Winter- and spring-run Chinook salmon, steelhead and green sturgeon are expected to continue to utilize the action area as a migratory corridor and for spawning and rearing. Despite its relatively small size, the value of the action area as a migratory corridor, and its suitability as spawning and rearing habitat, make it an important node of habitat for the survival and recovery of local populations of listed species. Because the action area is within the most important habitat available to winter-run Chinook salmon, the continuity and connectivity of the action area to the rest of their habitat is important for the survival and recovery of that ESU.

The information that is available on green sturgeon indicates that, as with winter-run Chinook salmon, the mainstem Sacramento River may be the last viable spawning habitat for the Southern DPS of North American green sturgeon (NMFS 2003). Because of similarities in their migration and spawn timing, it is likely that many of the same factors affecting winter-run Chinook salmon are also significant to green sturgeon. Because the action area is within the most important habitat available to the Southern DPS of North American green sturgeon, the continuity and connectivity of the action area to the rest of their habitat is important for the survival and recovery of that DPS.

Although the habitat within the action area may be important for the survival and recovery of local and upstream populations of spring-run Chinook salmon, the primary abundance of spring-run Chinook salmon in streams and rivers downstream of the action area, means that the value of the habitat within the action area may not be as essential for the survival and recovery of spring-run Chinook salmon as it is for winter- run and green sturgeon.

The Central Valley steelhead DPS' dependence on the action area is intermediate between that of winter- run and spring-run Chinook salmon. Like spring-run Chinook salmon, a significant proportion of the Central Valley steelhead DPS spawn downstream of the action area, although their population numbers are more evenly distributed upstream and downstream of RBDD than are spring-run Chinook salmon, and large spawning populations in the mainstem Sacramento

River and Battle Creek/Coleman National Fish Hatchery depend on the action area during both upstream and downstream migration and rearing.

V. EFFECTS OF THE ACTION

A. Approach to the Assessment

Pursuant to section 7(a)(2) of the ESA (16 U.S.C. 1536), Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. This biological opinion does not rely on the regulatory definition of “destruction or adverse modification” of critical habitat as defined in 50 CFR 402.02. Instead, this biological opinion relies upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat. NMFS will evaluate destruction or adverse modification of critical habitat by determining if the action reduces the value of critical habitat for the conservation of the species. This biological opinion assesses the effects of the proposed RBPP project on endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, threatened Central Valley steelhead, their designated critical habitats, and Southern DPS of North American green sturgeon.

In the section II, “Description of the Proposed Action,” of this biological opinion, NMFS provided an overview of the action. In the sections III and IV, “Status of the Species and Critical Habitat” and “Environmental Baseline,” respectively, NMFS provided an overview of the threatened and endangered species and critical habitat in the action area of this consultation.

Regulations that implement section 7(a)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. 1536; 50 CFR 402.02). Section 7 of the ESA and its implementing regulations also require biological opinions to determine if Federal actions would destroy or adversely modify the conservation value of critical habitat (16 U.S.C. 1536).

NMFS generally approaches “jeopardy” analyses in a series of steps. First, we evaluate the available evidence to identify the direct and indirect physical, chemical, and biotic effects of the proposed action on individual members of the listed species or aspects of the species' environment (these effects include direct, physical harm or injury to individual members of a species; modifications to something in the species' environment - such as reducing a species' prey base, enhancing populations of predators, altering spawning substrate, altering ambient temperature regimes; or adding something novel to a species' environment - such as introducing exotic competitors or noise disturbance). Once we have identified the effects of an action, we evaluate the available evidence to identify a species' probable response (including behavioral responses) to those effects to determine if those effects could reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death,

immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; among others). We then use the evidence available to determine if these reductions, if any, could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

To evaluate the effects of the proposed action, NMFS examined the proposed construction activities, habitat change or loss, and conservation measures, to identify likely impacts to listed anadromous salmonids and green sturgeon within the action area, based on the best available information.

The primary information used in this assessment include fishery information previously described in the "Status of the Species and Critical Habitat" and "Environmental Baseline" sections of this biological opinion; studies and accounts of the impacts of water diversions and in-river construction activities on anadromous species; and documents prepared in support of the proposed action.

B. Assessment

The proposed RBPP project includes activities that may adversely affect several life stages of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, or Southern DPS of North American green sturgeon. Adverse effects to these species and their habitat may result from damage to incubating eggs and harassment of juveniles and adults from pile driving activities, changes in water quality from excavation and construction activities, impingement and entrainment of juveniles inside the cofferdam, and loss of riparian vegetation from construction activities. The project includes integrated design features and avoidance and minimization measures to reduce many of these potential impacts.

Although the purpose of the proposed action is to improve the agricultural water diversion reliability and fish passage problems (*e.g.*, migration delays, mortality, and predation on juveniles) associated with the operation of RBDD, the operation of RBDD, including the new pumping plant, is not addressed here and instead will be addressed in the OCAP biological opinion. In general, however, the proposed RBPP project is expected to increase the flexibility of RBDD operations and reduce the adverse effects of that facility on anadromous fishes. Also, the project is expected to eliminate the need for operation of the Constant Head Orifice to divert water from Stony Creek. Overall, the demand of the TCCA for water is not expected to increase, and the proposed project will not constrain future RBDD operations.

1. Effects Associated with Construction Activities

Impacts to the listed species and their habitats would likely occur from constructing a new pump station at the Mill Site and trenching for the installation of the diversion conveyance pipelines across Red Bank Creek. These impacts include the potential for direct losses, injury, and indirect impacts to adult or juvenile salmon, steelhead, and green sturgeon and their habitats. At the Mill Site, impacts would likely occur from activities related to the grading of the site and excavation of the streambank, the installation of a large (up to approximately 1,400 linear feet) sheet pile cofferdam, and from stranding of fishes within the cofferdammed areas. At the Red Bank Creek

crossing, impacts to fry and juvenile life stages of all species would likely occur from activities related to site grading and preparation, cofferdam installation, and stranding of fish within the cofferdammed areas.

The primary features of construction would be excavation, construction of concrete structures, and fill and re-grading operations. Such activities would require large pieces of equipment, including cranes, front end loaders, pile drivers, back hoes, excavators, scrapers, bulldozers, dump trucks, and other basic construction equipment and tools for digging and moving soil, and pouring concrete. Additionally, because a large portion of the construction activity would occur near the Sacramento River, a sheet pile cofferdam, installed using a pile driver or similar piece of equipment, is necessary to establish dry areas for forming concrete structures. Approximately 2,000 linear feet of sheetpile would be required to construct various cofferdams in several locations.

Construction activities will occur concurrently for 18 months at two locations: at the Mill Site property to construct the fish screen, forebay, main pump station, and associated buildings; and from the Mill Site across Red Bank Creek to the existing TCCA Diversion forebay to construct the diversion conveyance system and outlet structure. Additionally, the road and bridge linking the existing TCCA diversion site to the new Mill Site diversion will be constructed concurrently and require approximately 6 months to complete.

a. Pile Driving

Pile driving will be necessary to install sheet piles to form the cofferdam around the fish screen work areas on the Sacramento River as well as to install the conveyance facilities across Red Bank Creek (Holt 2007c). Pile driving consists of driving steel pile columns and sheets into the riverbed with a mechanical hammer. The force of the hammer hitting a pile forms a sound wave that travels down the pile and causes the pile to resonate radially and longitudinally. Acoustic energy is formed as the walls of the steel pile expand and contract, forming a compression wave that moves through the pile. The outward movement of the pile wall sends a pressure wave propagating outward from the pile and through the riverbed and water column in all directions.

Because inconsistent mediums, such as water, will result in a higher rate of transmission loss, environmental factors such as water depth, water turbulence, air bubbles, and substrate consistency are important to consider when estimating the distance a compression wave will travel. A compression wave traveling through shallow water and substrates with variable consistencies (*i.e.*, variable particle size class distribution) will attenuate more rapidly than compression waves traveling through a constant medium such as deep water or bedrock. As a compression wave moves away from the source, the wavelength increases and intersects with the air/water interface. Once the compression wave contacts the air, it attenuates rapidly and does not return to the water column.

Salmon and steelhead eggs are very fragile, and thus, susceptible to mechanical shock prior to the eyed egg stage (Jensen and Alderice 1983, Piper *et al.* 1982). Chinook salmon eggs generally reach the eyed stage within 19 days of fertilization under typical fall water temperatures of 56°F in the action area (Piper *et al.* 1982). Steelhead eggs generally reach the

eyed stage within 12 days of fertilization under typical winter water temperatures of 48°F in the action area (Velson 1987). During this period of early development, high pressure compression shock waves may cause egg mortality in redds that are close to pile driving activities. In planning for the replacement of the Diestelhorst Bridge in Redding, California, engineering analysis concluded that driving small piles (such as sheet piles) would be likely to kill pre-eyed salmon and steelhead eggs located up to 150 feet from pile driving activities (Rectenwald 2002). River and substrate conditions in the action area generally are expected to be similar to those in the Redding area due to the proximity and similarity in width and character of the Sacramento River at the two locations, although the presence of Lake Red Bluff from April 15 through September 15 and resultant increase in water depth at the RBPP site may decrease the attenuation of the compression waves. As indicated in the “Environmental Baseline” section of this biological opinion, no Sacramento River winter-run Chinook salmon spawning has been observed in the reach just upstream of RBDD (*i.e.*, where pile driving will occur) in recent years. Central Valley steelhead and/or rainbow trout redds have been observed within the action area during aerial redd surveys, although these redds have not been counted or documented (Killam 2005). Some Central Valley spring-run Chinook salmon adults may spawn in this reach, but most Chinook spawning detected in this area are thought to be fall-run Chinook salmon. In addition, over half of spring-run Chinook salmon would be expected to spawn before September 26 (Vogel and Marine 1991), and therefore, be past the eye-up stage when pile driving starts on October 15. Exposure will further be reduced by establishing a 200-foot exclusionary zone around pile driving locations from April 15 through November 15, which covers the primary spawning period of winter- and spring-run Chinook salmon. Overall, the likelihood of exposure of salmonid eggs and larvae to pile-driving from the RBPP project is expected to be very low.

Given this information, NMFS expects that a very small fraction of the total egg production for the Central Valley spring-run Chinook salmon ESU and the Central Valley steelhead DPS will be affected by the proposed pile driving activities, and that the resulting loss of reproductive potential will not be of a magnitude that would appreciably reduce the likelihood of survival and recovery of these species.

(1) Immediate Mortality of Fish from Pile Driving. The effect of pile driving on free-swimming fish depends on the duration, frequency (Hz), and pressure (dB) of the compression wave. Rasmussen (1964) found that immediate mortality of juvenile salmonids may occur at sound pressure levels exceeding 204 dB. Due to their size, adult salmon steelhead and green sturgeon can tolerate higher pressure levels, and immediate mortality rates for adults are expected to be less than those experienced by juveniles (Hubbs and Rehnitz 1952). As sound pressure levels are not expected to exceed 180 dB, no immediate mortality of juvenile or adult fish is expected. Additionally, during sheet pile installation, adult salmon, steelhead, and/or green sturgeon would likely avoid the areas where these cofferdams are being installed. Death or injury to adults would not likely occur from any percussion impacts, as these adults would disperse from the immediate vicinity of the pile driving.

(2) Pile Driving Impacts on the Auditory Sensory Organs of Fish. High levels of underwater acoustic noises have been shown to have adverse impacts upon the auditory sensory organs of fish within close proximity of the noise source. Scholik and Yan (2002) examined the effects of boat engine noise on the auditory sensitivity of fathead minnow. Fish were exposed to a

recording of the noise generated by a 55 hp outboard motor over a period of 2 hours. The noise level was adjusted to 142 dB, which was equivalent to the noise levels measured at 50 meters from a 70 hp outboard motor. The experimental fish suffered a drop in hearing sensitivity over the range of frequencies normally associated with their hearing capabilities. These responses were measured using electrophysiological responses of their auditory nerves under general anesthesia. Studies by McCauley *et al.* (2003) on the marine pink snapper indicated that high-energy noise sources (approximately 180 dB maximum) can damage the inner ears of aquatic vertebrates by ablating the sensory hairs on their inner ear epithelial tissue as revealed by electron microscopy. Damage remained apparent in fish held up to 58 days after exposure to the intense sound. Although no studies utilizing salmonids have been conducted, auditory effects on these other fish species can serve as surrogates for salmonids, and it is reasonable to assume that some level of adverse impacts to salmonids can be inferred from the above results if they are subjected to similar intensities and durations of noise.

The loss of hearing sensitivity may negatively affect a salmonid's ability to orient itself (*i.e.*, due to vestibular damage), detect predators, locate prey, or sense their acoustic environment. Chronic noise exposure can reduce a fish's ability to detect piscine predators either by reducing the sensitivity of the auditory response or by masking the noise of an approaching predator. Disruption of the exposed fish's ability to maintain position or swim with the school will enhance its potential as a target for predators. Unusual behavior or swimming characteristics single out an individual fish and allow a predator to focus its attack upon that fish more effectively.

Impacts to larvae/post-larvae, fry, or juvenile life stages present near the Mill Site would likely occur during installation of cofferdams from pile driving activities. Direct physical loss or injury and indirect impacts from stress would likely occur during installation of sheet pile cofferdams. Some juvenile salmon, steelhead, or larval/post-larval green sturgeon would likely be killed or injured from the percussion impacts during sheet pile installation.

(3) Behavioral Responses to Pile Driving. Behavioral responses to high noise levels (startle response, avoidance, agitation, *etc.*) have been studied in salmonids with mixed results. Burner and Moore (1962) found that large juvenile and adult fish rarely responded to sudden or loud sound stimuli. Goetz *et al.* (2001) and Ploskey and Johnson (2001) found no difference between the reactions of treatment groups of Chinook salmon and coho salmon (*O. kisutch*) exposed to no sound and groups exposed to sounds reaching 170-180 dB.

Other experiments by McKinley and Patrick (1988) using pulsed sound, similar to pile driving, found that smaller juvenile salmonids demonstrated a startle or avoidance response. Feist *et al.* (1992) found that salmonids hear within a range of 10 to 400 Hz, with the greatest sensitivity between 180 and 190 Hz, and that pile-driving in Puget Sound created sound within the range of salmonid hearing that could be detected at least 600 m away. Abundance of juvenile salmon near pile driving rigs was reduced on days when the rigs were operating compared to non-operating days. Also, Shin (1995) found that pile driving may result in "agitation" of salmonids as indicated by a change in swimming behavior. These studies suggest that pile driving may cause startling and/or avoidance of habitat by fish in the immediate vicinity of a project site.

The startling of fish can cause injury by temporarily disrupting normal behaviors that are essential to growth and survival such as feeding, sheltering, and migrating. Injury is caused when disrupting these behaviors increases the likelihood that individual fish will face increased competition for food and space, and experience reduced growth rates or possibly weight loss. Disruption of these behaviors may also result in the death of some individuals due to increased predation if fish are disoriented or concentrated in areas with high predator densities. Disruption of these behaviors may occur for specific periods between October 15 and April 15 of each construction year, during daylight operation hours of the pile driving hammer. Downstream movement of fry occurs mainly at night, although small numbers of Chinook salmon fry move during daylight hours (Reimers 1973). Because of this nocturnal migratory behavior, daily migration delays are expected to impact only the portion of each ESU/DPS that migrates during daylight hours in the periods that pile driving activities are occurring. Lapses in pile driving activity are common throughout the day because construction crews suspend hammer work for equipment maintenance, to shift from one pile to another, and to take breaks (Whitley 2002). These construction lapses, including daily breaks and nighttime non-working periods, as well as long periods when no pile driving is scheduled to occur, will allow fish to migrate through the action area and minimize the extent of injury that occurs to populations.

The population-level effects of harassment to adult and juvenile Chinook salmon, steelhead and green sturgeon are expected to be limited in part, because pile driving activities will occur during the day, enabling unhindered fish passage at night. Also, the October 15 through April 15 percussive work window will avoid the primary spawning periods for winter and spring-run Chinook salmon and green sturgeon, as well as the primary outmigration period for juvenile winter-run Chinook salmon (July through October) and green sturgeon (June through September). Additionally, many subpopulations of Central Valley spring-run Chinook salmon and Central Valley steelhead occur in tributaries downstream of the action area (*e.g.*, Deer, Mill, and Butte Creeks, Yuba and Feather Rivers, *etc.*) and, therefore, are not expected to be affected by the proposed RBPP project at all.

b. Cofferdams Installation and Operation

Closure of cofferdams may entrap winter-run Chinook salmon, spring-run Chinook salmon, steelhead and green sturgeon. Cofferdam installation is expected to take 4 to 6 weeks. As specified in the proposed conservation measures, pile driving will be limited to the period from January 15 to November 15, and the detection of salmonid spawning habitat within the 200-foot exclusionary zone around pile driving locations will require additional precautions during the period from April 15 through November 15 (*i.e.*, ensuring that anti-spawning mats are in place prior to April 15 to prevent spawning in the area). The cofferdam installation process will likely startle most of the salmon near the construction site and cause them to leave the immediate area of work. However, some fish may be entrained when the cofferdam is closed. Direct losses, injuries, and stress to larval/post-larval, fry, and juvenile life stages could occur from isolation and stranding during the installation of cofferdams and from de-watering of the cofferdammed area.

Implementation of a fish salvage operation within the closed cofferdams will reduce potential mortality associated with entrapment and subsequent dewatering of the dammed area. Any fish

salvaged from the cofferdammed area would be relocated to the main stream channel. A low mortality rate (expected to be less than 10 percent if consistent with the results of fish handling in similar fish salvage efforts) is expected from capturing and handling.

c. In-stream Work

In-stream work, at both the Mill Site in the Sacramento River and the bridge site in Red Bank Creek, could increase suspended sediments and elevate turbidity above natural levels in the water column downstream of the construction areas. Activities that could contribute sediment and increase turbidity include sheet pile driving and removal, and use of near-river access roads and staging areas. Because the vast majority of instream construction activities will occur behind closed cofferdams, the potential for the project to cause significant increases in downstream turbidity levels is very low. While unlikely, there is always the potential for an unexpected storm event or other unplanned problem to result in the discharge of sediments from the project site.

High turbidity can affect fish by reducing feeding success, causing avoidance of rearing habitats, and disrupting upstream and downstream migration. Displacement of juveniles from preferred habitats may result in increased susceptibility to predation. Bisson and Bilby (1982) reported that juvenile coho salmon avoid turbidities exceeding 70 nephelometric turbidity units (NTUs), and Sigler *et al.* (1984) found that turbidities between 25 and 50 NTUs reduced growth of juvenile coho salmon and steelhead. Turbidity should affect Chinook salmon in much the same way it affects juvenile steelhead and coho salmon because of similar physiological and life history requirements between the species. Increased sediment delivery and high levels of turbidity also can cause infiltration of fine sediment into spawning gravels. This can lead to decreased substrate permeability and intergravel flow, resulting in oxygen depletion and mortality of incubating eggs and pre-emergent fry (Lisle and Eads 1991). Increased sediment delivery can also fill interstitial substrate spaces resulting in reduced abundance and availability of aquatic invertebrates for food (Bjornn and Reiser 1991).

Adherence to the preventative and contingency measures of the Stormwater Pollution Prevention Plan (SWPPP) will minimize the potential for project related-sediment plumes to be caused by unexpected storms or similar issues by removing excavation materials to locations outside of the river channel and halting work in the event of a plume being detected. Sediment management and preventative measures will minimize the amount of project-related sediment introduced to the waterway through the use of cofferdams, silt fences, straw mulch, and erosion control seeding. These measures are further described in section V.C, "Measures to Reduce the Impacts of Construction of the Project Facilities," below. In the event that a project-related sediment plume does occur, it is expected to be of short duration, since work would be suspended, and the plume would likely dissipate quickly downstream when mixed with the large volume of the Sacramento River. The sediment plume would be expected to result in a temporary change in the distribution of fish in the action area, lasting only as long as the plume was present.

Water quality may also be affected by hydraulic and fuel line leaks and petroleum spills. NMFS expects that the risk of introducing petroleum products or pollutants other than sediment to the waterway will be sufficiently minimized because the SWPPP will contain prevention and

contingency measures requiring frequent equipment checks to prevent leaks, keeping stockpiled materials away from the water, and requiring that absorbent booms are kept onsite to prevent petroleum products from entering the river in the event of a spill or leak.

These types of events are unlikely to affect migrating adults to the extent of injuring them, but may injure some juvenile fish, which are actively feeding and growing by temporarily disrupting normal behaviors that are essential to growth and survival. Injury would be caused when disruption of these behaviors increases the likelihood that individual fish will face increased competition for food and space, and experience reduced growth rates or possibly weight loss. Project-related turbidity increases may also affect the sheltering abilities of some juvenile fish and may decrease their likelihood of survival by increasing their susceptibility to predation. However, because of the short duration of the turbidity events, the low levels of injury and death that may occur to listed species from changes in feeding behavior, distribution and predation, are not expected to result in appreciable reductions in the species' likelihood of survival and recovery in the wild.

(1) *Habitat Loss or Alteration.* The permanent loss or alteration of an approximately 1,400-foot by 10-foot area of stream bank and water column habitat in the Sacramento River would occur from construction of the proposed fish screen facility at the Mill Site. Alteration of habitat would occur from the presence of a fish screen with some low probability of impingement or entrainment as well as increased vulnerability to predation by striped bass and pikeminnow. Additionally, the permanent alteration of an approximately 100-foot by 17-foot area of the wetted stream channel of Red Bank Creek and the permanent loss or alteration of an approximately 580-foot by 17-foot area of riparian habitat adjacent to Red Bank Creek would occur from construction of the new bridge. The bridge will span Red Bank Creek, so the only alterations to the wetted channel would include increased shading from the bridge, loss of shade and allochthonous input from existing trees that will have to be removed, and potentially increased traffic noise. However, because of the degraded condition of riparian habitat along the Mill Site, the small size of the other affected areas, the implementation of the proposed avoidance and minimization measures described in section II.C, "Proposed Avoidance and Minimization Measures," the limited term of the expected impacts, the abundance of other forms of overhead cover and shade (*e.g.*, pools, riffles and the bridge itself), and adequate aquatic food production, NMFS does not expect the reduction in riparian habitat values to appreciably reduce the listed species' likelihood of survival and recovery in the wild.

2. Effects of Project Operation and Maintenance

Because the proposed RBPP will be a part of the infrastructure of the CVP, the future operation and maintenance of the project facilities are being appropriately addressed within the consultation for OCAP for the CVP. Therefore, the effects of future project operations and maintenance are not analyzed in this biological opinion.

C. Measures to Reduce the Impacts of Construction of the Project Facilities

The avoidance and minimization measures proposed by Reclamation and described in section II.C, "Proposed Avoidance and Minimization Measures," would offset or avoid many of the potential impacts of implementing the RBPP project.

Reclamation has proposed the following avoidance and minimization measures to address potential project-related impacts to fish resources (CH2MHill 2001).

- Placement of sheet pile (in-stream work) would take place in July and August.
- Potential suitable spawning areas identified within 200 feet of pile-driving locations would have anti-spawning mats securely installed at least 90 days prior to pile-driving activities. These mats would remain in place throughout construction activities to discourage adult fish from spawning in the immediate vicinity of the construction area.
- All dewatered areas within cofferdams would be pumped down using a screened intake on the dewatering pumps. Pumping would continue until water levels within the contained areas are suitable for salvage of any juvenile or adult fish occupying these areas. Fish would be removed by methods approved by NMFS and CDFG prior to final dewatering.
- The construction contractor shall obtain a General Construction Storm Water Permit, to comply with the Clean Water Act, section 402(b) for construction of all facilities. As part of this permit, the contractor would prepare an erosion control plan as part of the SWPPP, which would include the following BMPs:
 - All ground-disturbing activities would be limited to the dry season (mid-May through mid-October) to the extent possible;
 - Existing vegetation would be left in place to the degree possible to reduce potential sedimentation;
 - All stockpiled material would be placed so that potential for erosion is minimized;
 - Filter fabric, straw bales, and/or sediment basins would be used to reduce erosion and the potential for instream sedimentation; and
 - Seeding and re-vegetation would be initiated as soon as possible (timed properly to coincide with fall/winter precipitation) after construction completion.
 - To the extent possible, areas of riparian vegetation temporarily disturbed during construction would be planted with native riparian trees and shrubs to restore the impacted habitat following construction. The permanent removal of riparian vegetation would be mitigated by creating riparian habitat at a 3:1 ratio for impacted acreage. Reclamation will work with NMFS, CDFG and USFWS to identify appropriate locations for riparian habitat creation and restoration to compensate for permanent impacts in the action area. The acreage of riparian habitat impacted would be determined based on final design drawings.
- Placement of cofferdams to isolate construction activities that have the potential for discharging soils and sediments into the active channel.
- Implement bank excavation techniques to minimize and prevent, to the greatest extent possible, soil material from entering the active channel.
- Monitor turbidity during cofferdam placement and construction to ensure that they do not result in increased turbidity that would have deleterious effects on listed species in the action area.
- Ceasing construction activities when turbidity approaches or exceeds acceptable criteria established by the Central Valley Regional Water Quality Control Board (CVRWQCB).

Construction activities may resume only after turbidity levels downstream of the project construction site return to acceptable levels established by the CVRWQCB.

- Any heavy equipment necessary for installation or removal of sheet pile cofferdams would be operated from either a floating barge or from the top of the streambank.
- No more than one vehicle with tracks or wheels would be permitted to enter or operate within any wet portion of the stream channel at any time.
- All vehicles operated within the wet portion of the stream channel would enter and exit the active channel through one location (access point).
- All other vehicles accessing work areas adjacent to and within the wet portion of the stream channel would be operated on existing roads, hardened access ramps, or within contained areas inside cofferdams.
- Any vehicle operated within the wet portion of the stream channel should be free of petroleum residues, and any vehicle's fuel, lubricant, and/or fluids should be contained within watertight reservoirs.
- Operation of any vehicle within the wet portion of the stream channel should be minimized and only as necessary to accomplish construction-related tasks.

D. Beneficial Effects of the RBPP Project

Although the operation of RBDD will be addressed in the OCAP consultation, the proposed project would provide operational flexibility to RBDD for adult and juvenile listed species, and provide reliable water delivery to TCCA.

E. Interrelated or Interdependent Actions

Regulations that implement section 7(b)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. 1536; 50 CFR 402.02). There are no interrelated or interdependent actions associated with the proposed action.

VI. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

The only cumulative effects of future (and current) State, local and private actions that are reasonably certain to occur in the action area are those of global climate change. The future effects of global climate change in the action area are expected to be similar to those described for the entire range of the listed species in Section III. C. 1. c. Increases in rainfall and decreases in snow pack in the southern Cascades will affect cold-water pool storage in Shasta reservoir, upstream of the action area, affecting river hydrology, flow patterns and water

temperatures in the action area. As the action area is already the downstream-most extent of suitable water temperatures for winter- and spring-run Chinook salmon spawning (only in the coldest water years), it is likely that the projected increase in water temperatures will render the action area unsuitable for Chinook salmon spawning during the summer and early fall months (winter- and spring-run Chinook salmon spawning periods).

VII. INTEGRATION AND SYNTHESIS

The purpose of this section is to summarize the effects of the action and add those effects to the impacts described in the “Environmental Baseline” and “Cumulative Effects” sections of this biological opinion in order to inform the conclusion of whether or not the proposed action is likely to jeopardize the continued existence of the listed salmonids and North American green sturgeon, or destroy or adversely modify designated critical habitat.

Populations of Chinook salmon, steelhead and green sturgeon in California have declined drastically over the last century, and some subpopulations have been extirpated. The current status of listed salmonids within the action area, based upon their risk of extinction, has not significantly improved since the species were listed (Good *et al.* 2005). For example, although the number of Sacramento River winter-run Chinook salmon has increased in the last 6 years, the ESU remains at risk of extinction (Good *et al.* 2005). This severe decline in population over many years, and in consideration of the degraded environmental baseline, demonstrates the need for actions which will assist in the recovery of all of the ESA-listed species in the action area, and that if measures are not taken to reverse these trends, the continued existence of salmonids and sturgeon could be at risk.

NMFS expects that the RBPP project will result in short-term construction-related impacts that will injure, harm and possibly kill mainly juveniles, but possibly larvae/post-larvae and fry life stages, of the listed salmonids and Southern DPS of North American green sturgeon and remove or alter their habitat. However, the adverse effects to these listed species within the action area are not expected to affect the overall survival and recovery of the ESUs and DPS. This is largely due to the fact that Reclamation will implement measures outlined in section II.C, “Proposed Avoidance and Minimization Measures,” as part of the proposed project to avoid, minimize, or mitigate any temporary and permanent habitat losses and other construction-related disturbances. The number of individuals actually injured or killed is expected to be small in proportion to the sizes of the respective populations. Therefore, population-level impacts are not anticipated. Overall, construction-related impacts to the listed species will be temporary and will not impede adult fish from reaching upstream spawning and holding habitat, or juvenile fish from migrating to downstream rearing areas.

The cumulative affects of global climate change are not expected to be additive to the temporary, construction-related effects of the proposed project because project effects are expected to have fully dissipated prior to the period when significant climate change effects are projected to occur in the action area.

VIII. Conclusion

After reviewing the best scientific and commercial information available, the current status of the species, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects, it is NMFS' biological opinion that the RBPP project, as proposed, is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, or Southern DPS of North American green sturgeon. In addition, NMFS has determined that the RBPP project, as proposed, is not likely to destroy or adversely modify critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibits the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not the purpose of the agency action is not considered to be prohibited taking under the ESA, provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The listing of the Southern DPS of North American green sturgeon became effective on July 7, 2006, and some or all of the ESA section 9(a) prohibitions against take will become effective upon the future issuance of protective regulations under section 4(d). Because there are no section 9(a) prohibitions at this time, the incidental take statement, as it pertains to the Southern DPS of North American green sturgeon, does not become effective until the issuance of a final 4(d) regulation, as appropriate.

The measures described below are non-discretionary, and must be undertaken by Reclamation so that they become binding conditions of any contract, grant or permit, as appropriate, for the exemption in section 7(o)(2) to apply. Reclamation has a continuing duty to regulate the activity covered by this incidental take statement. If Reclamation: (1) fails to assume and implement the terms and conditions, or (2) fails to require the contractors to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the contract, permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Reclamation must report the progress of the action and its impact on the species to NMFS as specified in the incidental take statement [50 CFR 402.14(i)(3)].

A. Amount and Extent of Take

NMFS anticipates incidental take of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and the Southern DPS of North American green sturgeon from impacts related to construction of the RBPP project as a result of reductions in the quality or quantity of their habitat.

NMFS cannot, using the best available information, accurately quantify the anticipated incidental take of individual listed fish because of the variability and uncertainty associated with the population size of each species, annual variations in the timing of migration, and uncertainties regarding individual habitat use of the action area. However, it is possible to designate ecological surrogates for the extent of take anticipated to be caused by the RBPP project, and to monitor those surrogates to determine the level of take that is occurring. The four most appropriate ecological surrogates for the extent of take caused by the RBPP project are: the amount, duration and timing of pile driving associated with instream cofferdam construction; the mortality rate of fish rescued from within cofferdams; the turbidity levels produced by instream construction activities; and the 3:1 replacement of permanently impacted riparian habitat.

1. Ecological Surrogates

- The analysis of the effects of the proposed RBPP project anticipates that a maximum of 2200 linear feet of sheet piling will be driven over a period of 6 weeks to create the necessary cofferdams, and that pile driving will occur only during daylight hours.
- The analysis of the effects of the proposed RBPP project anticipates that the mortality rates of fish rescued from within cofferdams are not expected to exceed 10 percent of all listed species detected within the enclosed areas.
- The analysis of the effects of the proposed RBPP project anticipates that the turbidity levels produced by instream construction activities will not exceed those permitted under the project SWPPP and that if turbidity levels approach or exceed the acceptable criteria established by the CVRWQCB, construction activities will be halted until turbidity levels return to within acceptable levels.
- The analysis of the effects of the proposed RBPP project anticipates that permanently impacted riparian vegetation will be replaced at a 3:1 ratio with appropriate, native riparian habitat that will be protected in perpetuity.

If these ecological surrogates are not met and maintained, the proposed RBPP project will be considered to have exceeded anticipated take levels, triggering the need to reinitiate consultation on the RBPP project.

B. Effect of the Take

NMFS has determined that the level of take associated with the implementation of the RBPP project is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, or the Southern DPS of North American green sturgeon.

C. Reasonable and Prudent Measures

NMFS believes that the following reasonable and prudent measures are necessary and appropriate to minimize take of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and Southern DPS of North American green sturgeon resulting from implementation of the action. These reasonable and prudent measures also would minimize adverse effects on designated critical habitat:

1. Reclamation shall minimize noise-related impacts resulting from pile driving of sheet piles for cofferdams.
2. Reclamation shall take the necessary measures to maintain and adaptively manage all conservation measures throughout the life of the project to ensure their long-term effectiveness.

D. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, Reclamation must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline specific reporting and monitoring requirements. These terms and conditions are nondiscretionary.

1. Reclamation shall minimize noise-related impacts resulting from pile driving of sheet piles for cofferdams.
 - a. In order to minimize the magnitude of sound and energy waves produced during pile driving, Reclamation shall mandate that vibratory hammers be used for sheet pile driving wherever it is feasible to do so (where substrate allows the use of vibratory hammers to drive sheet piles).
2. Reclamation shall take the necessary measures to maintain and adaptively manage all conservation measures throughout the life of the project to ensure their long-term effectiveness.
 - a. Reclamation shall minimize bank revetment (riprap) at the Mill Site to the minimum length needed for hydraulic performance and structural integrity of the fish screen.
 - b. Reclamation shall implement the selected mitigation options prior to, or concurrent with, project construction to expeditiously replace habitat values lost due to the proposed project.

- c. Reclamation shall develop and implement, in cooperation with the USFWS, NMFS, CDFG, and TCCA, an evaluation and monitoring plan to assess the adequacy of the fish screen in meeting biological and engineering design criteria and propose corrective measures. Reclamation shall:
 - o Monitor screen criteria for the period of time necessary to evaluate screen performance at a range of river flows and pumping rates;
 - o Identify operational flexibilities that would provide the greatest level of fisheries protection at various river flows and pumping rates; and
 - o Perform biological evaluations using available technology (direct observation, video, acoustic/sonar, *etc.*) as appropriate, to evaluate the effectiveness and/or impacts of the screens to juvenile salmonids and other target species.
- d. Reclamation shall provide a project summary and compliance report to NMFS at the end of each calendar year until the RBPP project and all terms and conditions have been implemented. This report shall describe construction dates, implementation of avoidance and minimization measures, and the terms and conditions of the biological opinion; observed or other known effects on Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and the Southern DPS of North American green sturgeon, if any; and any occurrences of incidental take of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and the Southern DPS of North American green sturgeon.
- e. Reports shall be submitted to:
 - Sacramento Area Office
 - National Marine Fisheries Service
 - 650 Capitol Mall, Suite 8-300
 - Sacramento California 95814-4706
 - Phone: (916) 930-3600
 - FAX: (916) 930-3629

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations applicable to the RBPP project to address specific limiting factors have been identified for the listed salmonids and Southern DPS of North American green sturgeon include the following:

1. Reclamation should initiate year-round gates-up operation of RBDD once the RBPP is fully operational.
2. Once the RBPP is fully operational, and the TCC is able to get its full water allotment from this facility throughout the year, Reclamation should dedicate available CVP water stored in Black Butte Reservoir (currently used to supplement TCC supplies when RBDD gates are raised) as instream flows to improve salmonid habitat in lower Stony Creek.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, NMFS requests notification of implementation of any conservation recommendations.

XI. REINITIATION OF CONSULTATION

This concludes formal consultation for the RBPP project in Tehama County, California. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

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Magnuson-Stevens Fishery Conservation and Management Act**ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS****I. IDENTIFICATION OF ESSENTIAL FISH HABITAT**

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), as amended (U.S.C. 1801 *et seq.*), requires that Essential Fish Habitat (EFH) be identified and described in Federal fishery management plans (FMPs). Federal action agencies must consult with NOAA's National Marine Fisheries Service (NMFS) on any activity which they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies.

EFH is defined as those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purposes of interpreting the definition of EFH, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and, "spawning, breeding, feeding, or growth to maturity" covers all habitat types used by a species throughout its life cycle. The action area of the Red Bluff Pumping Plant project is within the area identified as EFH for Pacific Coast Salmon species identified in Amendment 14 of the Pacific Salmon FMP [Pacific Fishery Management Council (PFMC) 1999].

PFMC (1999) has identified and described EFH, and has identified adverse impacts and recommended conservation measures for salmon in amendment 14 to the Pacific Coast Salmon FMP. Freshwater EFH for Pacific salmon in the California Central Valley includes waters currently or historically accessible to salmon within the Central Valley ecosystem as described in Myers *et al.* (1998). Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), and Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) are species managed under the Pacific Coast Salmon FMP that occur in the Central Valley.

A. Life History and Habitat Requirements of Pacific Salmon

General life history information for Central Valley fall/late-fall Chinook salmon is summarized below. Information on Sacramento River winter-run and Central Valley spring-run Chinook salmon life histories is summarized in the preceding biological opinion for the proposed project (enclosure 1). Further detailed information on Chinook salmon Evolutionarily Significant Units (ESU) are available in the NMFS status review of Chinook salmon from Washington, Idaho, Oregon, and California (Myers *et al.* 1998), and the NMFS proposed rule for listing several ESUs of Chinook salmon (March 9, 1998, 63 FR 11482).

Adult Central Valley fall-run Chinook salmon enter the Sacramento and San Joaquin Rivers from July through December and spawn from October through December, while adult Central Valley late fall-run Chinook salmon enter the Sacramento and San Joaquin Rivers from October to April and spawn from January to April [U.S. Fish and Wildlife Service (USFWS) 1998].

Chinook salmon will spawn in water that ranges from a few centimeters to several meters deep provided that there is suitable sub-gravel flow (Healey 1991). Spawning typically occurs in gravel beds that are located in marginally swift riffles, runs and pool tails with water depths exceeding one foot and velocities ranging from one to 3.5 feet per second. Preferred spawning substrate is clean loose gravel ranging from one to four inches in diameter with less than 5 percent fines (Reiser and Bjornn 1979).

Egg incubation occurs from October through March (Reynolds *et al.* 1993). Shortly after emergence from their gravel nests, most fry disperse downstream towards the Delta and into the San Francisco Bay and its estuarine waters (Kjelson *et al.* 1982). The remaining fry hide in the gravel or station in calm, shallow waters with bank cover such as tree roots, logs, and submerged or overhead vegetation. These juveniles feed and grow from January through mid-May, and emigrate to the Delta and estuary from mid-March through mid-June (Lister and Genoe 1970). As they grow, the juveniles associate with coarser substrates along the stream margin or farther from shore (Healey 1991). Along the emigration route, submerged and overhead cover in the form of rocks, aquatic and riparian vegetation, logs, and undercut banks provide habitat for food organisms, shade, and protect juveniles and smolts from predation.

II. PROPOSED ACTION

The proposed action, the Red Bluff Pumping Plant project, is described in section II (*Description of the Proposed Action*) of the preceding biological opinion (enclosure 1). In general, the Bureau of Reclamation proposes to construct a new pump station with fish screen at the Mill Site, and install a conveyance facility across Red Bank Creek to convey water from the pump station to the Tehama-Colusa Canal, on the right bank of the Sacramento River in Red Bluff, California.

III. EFFECTS OF THE PROJECT ACTION

The effects of the proposed action on Sacramento River winter-run and Central Valley spring-run Chinook salmon habitat are described at length in section V (*Effects of the Action*) of the preceding biological opinion, including the loss of riparian vegetation, temporal loss of spawning habitat, and temporal loss of access to areas to be cofferdammed, and are generally expected to apply to Pacific Coast Salmon EFH.

IV. CONCLUSION

Based on the best available information, NMFS believes that the proposed Red Bluff Pumping Plant project would adversely affect EFH for Pacific salmon.

V. EFH CONSERVATION RECOMMENDATIONS

NMFS recommends terms and conditions 1, 2.a, and 2.b from the preceding biological opinion (enclosure 1) be adopted as EFH Conservation Recommendations.

VI. STATUTORY REQUIREMENTS

Section 305(b)(4)(B) of the MSFCMA requires that the Federal agency provide NMFS with a detailed written response within 30 days, and 10 days in advance of any action, to the EFH conservation recommendations, including a description of measures adopted by the Federal agency for avoiding, minimizing, or mitigating the impact of the project on EFH [50 CFR 600.920(j)]. In the case of a response that is inconsistent with our recommendations, Reclamation must explain its reasons for not following the recommendations, including the scientific justification for any disagreement with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, or mitigate such effects.

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II. DESCRIPTION OF THE PROPOSED ACTION

Reclamation proposes to construct a new pump station with fish screen at the Mill Site, and install a conveyance facility across Red Bank Creek to convey water from the pump station to the Tehama-Colusa Canal (TCC), on the right bank of the Sacramento River in Red Bluff, California (figure 1). The need for the RBPP project is driven by the continued and well-documented fish passage and agricultural water diversion reliability problems associated with the operation of RBDD, located on the Sacramento River just downstream of the City of Red Bluff. NMFS (2004) discussed these problems in its biological opinion on the long-term operations criteria and plan (OCAP) for the Central Valley Project (CVP) and State Water Project. Even with the current fish ladders in operation, RBDD continues to impede fish passage during the gates-in period from May 15 through September 15. The 4-month window of operation has constrained operation of the dam for diversion purposes to the point that the applicant, Tehama-Colusa Canal Authority (TCCA), cannot reliably meet the water needs of its customers when the gates are out. Construction of the RBPP project will result in no increase in water deliveries compared to current permitted amounts, but will provide greater flexibility to RBDD gate operations (Holt 2007a).

The purposes of the RBPP project are: (1) to allow for substantial improvement in the long-term ability to reliably pass anadromous fish and other species of concern, both upstream and downstream, past RBDD through additional gate openings, if deemed necessary or desirable through future reviews of RBDD operations; and (2) to substantially improve the long-term ability to reliably and cost effectively move sufficient water into the TCC and Corning Canal systems to meet the needs of the water agencies served by TCCA.

A. Proposed Facilities

The maximum capacity of the proposed RBPP is anticipated to be 2,500 cubic feet per second (cfs), which corresponds with the 2,500 cfs approximate existing combined maximum capacity of the TCC and Corning Canal (Holt 2007a, 2007b). This will allow for the eventual retirement of the existing 320 cfs Research Pumping Plant (RPP) while retaining the ability to pump at maximum capacity of 2,500 cfs.

1. Mill Site Pump Station and Fish Screen

The Mill Site pump station and fish screen (hereafter referred to as the Mill Site) are located upstream from RBDD and Red Bank Creek (figure 1). The Mill Site configuration will consist of trash racks, fish screen, forebay, pump station, and conveyance facilities. Most of the site is on a bluff adjacent to the Sacramento River (Campbell 2007). However, in-channel construction will be required to install the fish screen, and will result in the loss of an area of riparian and aquatic habitat measuring approximately 10 feet wide by 1,400 feet long (Holt 2007a, 2007b). Due to monitoring results at other locations and river hydraulics at the site, Reclamation and TCCA staff believe that a fish bypass system may lead to increased predation of juvenile fish; therefore, a fish bypass system is not proposed as part of this project.

The discharge piping would be routed to a new discharge outlet structure at the existing sedimentation basin. Existing drum screens would be removed. When RBDD gates are out, water would be pumped. When the RBDD gates are in, water would be diverted by gravity through the new fish screen into the sedimentation basin. The objective of the positive-barrier fish screen design is to provide safe fish passage for juvenile fish (primarily sturgeon, salmon, and steelhead) past TCCA water diversion facilities.

The screen would be designed to meet all California Department of Fish and Game (CDFG) and NMFS criteria for the protection of salmonids. Reclamation and TCCA have assumed in designing this project that these criteria would be sufficient to protect green sturgeon (CH2MHill 2007). The length of the screen would depend on the characteristics of the river (*e.g.*, depth, channel geometry, flow volume, and velocity under various operating conditions) at the screen location, and is estimated to be 1,400 feet. The screen panels would be installed in approximately 60 bays. Blowout panel(s) would be included as an emergency hydraulic relief system in the event of excessive differential head between the river and the forebay. Bulkhead elevation would be set at the 25-year flood elevation to restrict the amount of debris in the forebay for flood events. Construction of the screen would require a temporary cofferdam to allow the site to be dewatered while the screen panels and appurtenant facilities are constructed.

Water would flow through the fish screen into the pump station forebay and into the vertical propeller pump station. Approximately 10 pumps would be required to achieve a pumping capacity of 2,500 cfs. The pumps would lift the water to the pump station outlet box. The water would then flow by gravity from the outlet box through a siphon under Red Bank Creek. The water would discharge into the sedimentation basin (figure 1).

At Reclamation's discretion, the existing RPP would remain in place, continuing its function as a research station for study of the effects of pumped diversions on fish numbers. The RPP would be operated at the discretion of Reclamation. This facility would not be included as part of the diversions for TCCA water deliveries.

2. Conveyance Facilities across Red Bank Creek

The land where the pump station and conveyance facilities would be constructed is adjacent to land owned by the Federal government for RBDD and is currently available for purchase. Power supply is nearby, and access is in place. Direct access to the pump station site from the existing RBDD site would require a bridge across Red Bank Creek. The conveyance system under Red Bank Creek would consist of pipes or culverts, or their combination, and would be sized for a maximum velocity of 8 feet per second at peak flow. The preliminary design report for the project (CH2MHill 2001) indicates that the conveyance facilities would consist of three box culverts each with a cross-section measuring 10 feet by 12 feet. The discharge structure at the sedimentation basin will be located along the westerly side of the sedimentation basin. The wetted stream channel of Red Bank Creek at the location of the proposed bridge and conveyance system is approximately 100 feet wide when Lake Red Bluff is present (Freeman 2007). The proposed bridge would be approximately 680 feet long by 17 feet wide, and would span Red Bank Creek (CH2MHill 2001). Approximately 160 square feet of fill would be required, and "dense trees" are identified as being present (CH2MHill 2001).

B. Construction Activities

RBPP project would require construction activities at: (1) the fish screen, forebay, main pump station and associated buildings at the Mill Site property for a period of approximately 18 months; (2) the diversion conveyance system and outlet structure running from the Mill Site across Red Bank Creek to the existing TCCA Diversion forebay for a period of approximately 18 months; and (3) the road and bridge linking the existing TCCA diversion site to the new Mill Site diversion for a period of approximately 6 months. Because construction at the sites will be conducted simultaneously, total construction time would require approximately 18 months. Construction will be independent of river flows, RBDD gate operations, and TCCA diversions, and is estimated to be completed by fall 2010. Construction would likely consist of: (1) establishing staging areas, (2) establishing access roads and bridge, (3) installing a cofferdam at the Mill Site, (4) constructing new facilities, and (5) demobilizing and cleaning up.

1. Staging Areas

Before construction, equipment would be brought to a location near the construction site. For the Mill Site fish screen, forebay, main pump station and associated new buildings, a staging area would be located on vacant land at the northwest end of the proposed Mill Site location. Placement of an additional staging area between the right bank of Red Bank Creek and the existing TCCA diversion forebay (figure 1) would allow storage and access of equipment throughout the entire construction location. Vegetation clearing at the staging areas and at the location of each of the construction sites would be required.

Materials and equipment will be stored in staging areas. Typical items in the staging areas will include sheet pile, building materials, support beams, cranes, backhoes, compressors, and various hand tools needed for construction. The staging areas will also be used as a construction crew parking area to accommodate up to 100 construction workers at the height of construction at any of the sites. Access roads leading into the construction site and at staging areas would be fenced to keep the public out of the construction and staging areas.

2. Access Roads and Bridge

The construction of the diversion conveyance system and outlet structure would require construction of a gravel access road across vacant land to the fish screen and pump station location and along and adjacent to the proposed conveyance system. Construction of the access bridge across Red Bank Creek also would be necessary to allow construction equipment and materials to be moved between the Mill Site and the existing TCCA diversion facility (figure 1). Vegetation clearing along the access roads would be required.

3. Cofferdam Installation

After establishing the staging areas, a steel sheet pile cofferdam would be constructed at the Mill Site fish screen work area to isolate construction activities from the Sacramento River. A crane, either on land or on a barge, with a pile driving apparatus, would be used to drive sheet pile to

form the cofferdam around the fish screen work areas. A cofferdam likely would be needed to install the conveyance facilities across Red Bank Creek as well (Holt 2007c). Cofferdam installation is expected to take 4 to 6 weeks. Once the cofferdam is installed, pumps would dewater the area.

4. Constructing New Facilities

In-channel construction would be required in the Sacramento River to install the fish screen, and in Red Bank Creek to install the conveyance facilities and bridge (Holt 2007c). Before construction, site grading and excavation at the various construction locations will be required. Following site preparation, construction of the fish screen facility, pump station, forebay and its associated buildings, and conveyance facilities will utilize standard reinforced concrete construction techniques. Concrete trucks or a batch concrete plant will provide concrete materials to the various construction locations. Then, concrete will be pumped to each facility construction site. Concrete will be formed into the structures necessary for each facility's completion. Although the completed conveyance facilities will pass under Red Bank Creek, trenching in the stream channel will be required to complete construction using this method (*i.e.*, pouring concrete into forms for culvert construction "in place;" Holt 2007c).

5. Demobilization and Cleanup

Cofferdams will be removed following completion of the facilities. Underwater divers will cut the steel sheet pile at the surface of the river bottom before removing the steel sheet pile by crane operating from either a barge or on land. Re-grading of the surrounding areas will also be necessary at the construction sites. Where necessary, re-vegetation will be completed before cleanup. Construction equipment will be moved to the staging area, where it will be trucked back to the construction contractor's storage yard.

C. Proposed Avoidance and Minimization Measures

1. Avoid or Minimize Percussion Impacts to Incubating Salmonid Embryos

Salmonid embryos are sensitive to vibrations following the time of fertilization until the eyed stage of development. Pounding of sheet piles or other materials during construction can cause mortality of developing eggs within redds nearby. To ensure listed salmonids are protected during construction, an exclusionary zone of 200 feet will be identified around the fish screen construction site where pile driving will occur to ensure adequate protection to incubating salmonid embryos.

To minimize the potential for percussion-related impacts (including sound) to Sacramento River winter-run and Central Valley spring-run Chinook salmon, the following minimization measures will be applied:

- If Chinook salmon spawning habitat is in the exclusionary zone, pile driving or other construction pounding will be limited to the period from January 15 to April 15.
- If Chinook salmon spawning habitat is in the exclusionary zone, pile driving or other construction pounding can occur from April 15 through November 15, provided anti-

spawning mats are placed over suitable spawning habitat before April 15. The placement of anti-spawning mats will prevent listed Chinook salmon from spawning within the exclusionary zone; therefore, percussion impacts to salmon embryos will be avoided. Anti-spawning mats will be removed after October 15, or when cofferdams are removed.

- If there is no spawning habitat in the exclusionary zone, pile driving or other construction pounding will be limited to the period between January 15 and November 15.

2. Avoid or Minimize Increased Turbidity and Suspended Sediment

Reclamation will comply with section 401 of the Clean Water Act through issuance of a water quality certification or a waiver from the Regional Water Quality Control Board to minimize the potential effects of increases in suspended sediment and water turbidity for a distance of 500 feet downstream of construction activities.

3. Avoid or Minimize Impacts to Riparian and Shaded Riverine and Aquatic Habitat

The project will avoid and minimize losses to riparian vegetation adjacent to the river channel to the fullest extent possible. Any mature cottonwood trees near construction areas will be flagged and avoided during construction to the fullest extent possible. When loss of riparian vegetation along the river is unavoidable, replanting will occur at a ratio of 3:1 for each woody riparian plant and/or linear foot of shaded riverine aquatic habitat lost because of project construction. The loss of riparian and shaded riverine aquatic habitat is anticipated to occur primarily along the 1,400-foot length of riverbank where the fish screen will be installed (figure 1). Reclamation will work with NMFS, CDFG and USFWS to identify appropriate locations for riparian habitat creation and restoration to compensate for permanent impacts in the action area. For temporary impacts that can be mitigated onsite, a mitigation ratio of 1:1 per woody plant and/or linear distance will be implemented.

4. Avoid or Minimize Impacts to Rearing Salmonids during Fish Screen Construction

The following measures will be implemented to reduce potential impacts to listed juvenile salmonids during installation of sheet pile at the fish screen construction site. The upstream end of the cofferdam will be installed first, and rearing salmonids will be given 1 day to voluntarily leave the construction area. Prior to placement of the downstream end of the sheet pile cofferdam and commencement of construction activities, a seine and/or backpack electrofisher will be used by qualified fishery biologists to capture any remaining juvenile salmonids, transport them downstream of the construction area, and release them unharmed into the Sacramento River.

D. Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For the purposes of this biological opinion, the action area encompasses: (1) the lateral 200 feet of the Sacramento River beginning at the right bank, from 200 feet upstream of the Mill Site construction area to 500 feet downstream of RBDD. This area was selected because it represents the upstream and

lateral extents of anticipated acoustic effects from pile driving, and downstream extent of anticipated effects related to increases in suspended sediment and turbidity; and (2) Red Bank Creek, from the proposed location of the bridge, downstream approximately 600 feet to the confluence of the Sacramento River.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

The following Federally listed species evolutionarily significant units (ESU) or distinct population segments (DPS) and designated critical habitat occur in the action area and may be affected by the proposed project:

- Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*), endangered (June 28, 2005, 70 FR 37160)
- Sacramento River winter-run Chinook salmon designated critical habitat (June 16, 1993, 58 FR 33212)
- Central Valley spring-run Chinook salmon ESU (*O. tshawytscha*), threatened (June 28, 2005, 70 FR 37160)
- Central Valley spring-run Chinook salmon designated critical habitat (September 2, 2005, 70 FR 52488)
- Central Valley steelhead DPS (*O. mykiss*), threatened (January 5, 2006, 71 FR 834)
- Central Valley steelhead designated critical habitat (September 2, 2005, 70 FR 52488)
- Southern DPS of North American green sturgeon (*Acipenser medirostris*), Threatened (April 7, 2006, 70 FR 17386)

A. Species Life History, Population Dynamics, and Likelihood of Survival

1. Chinook Salmon

Chinook salmon are anadromous and the largest member of *Oncorhynchus*, with adults weighing more than 120 pounds having been reported from North American waters (Scott and Crossman 1973, Eschmeyer *et al.* 1983, Page and Burr 1991). Chinook salmon exhibit two generalized freshwater life history types (Healey 1991). “Stream-type” Chinook salmon enter freshwater months before spawning and reside in freshwater for a year or more following emergence, whereas “ocean-type” Chinook salmon spawn soon after entering freshwater and migrate to the ocean as fry or parr within their first year. Spring-run Chinook salmon exhibit a stream-type life history. Adults enter freshwater in the spring, hold over the summer, spawn in the fall, and the juveniles typically spend a year or more in freshwater before emigrating. Winter-run Chinook salmon are somewhat anomalous in that they have characteristics of both stream- and ocean-type races (Healey 1991). Adults enter freshwater in the winter or early spring, and delay spawning until spring or early summer (stream-type). However, juvenile winter-run Chinook salmon migrate to sea after only 4 to 7 months of river life (ocean-type). Adequate instream flows and cool water temperatures are more critical for the survival of Chinook salmon exhibiting a stream-type life history due to over-summering by adults and/or juveniles.

Chinook salmon typically mature between 2 and 6 years of age (Myers *et al.* 1998). Freshwater entry and spawning timing are generally thought to be related to local water temperature and

flow regimes. Runs are designated on the basis of adult migration timing. However, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and the actual time of spawning (Myers *et al.* 1998). Both spring-run and winter-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months. For comparison, fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991).

Information on the migration rates of adult Chinook salmon in freshwater is scant and primarily comes from the Columbia River basin, where information regarding migration behavior is needed to assess the effects of dams on travel times and passage (Matter and Sanford 2003). Keefer *et al.* (2004) found migration rates of Chinook salmon ranging from approximately 10 kilometers (km) per day to greater than 35 km per day and to be primarily correlated with date, and secondarily with discharge, year, and reach, in the Columbia River basin. Matter and Sanford (2003) documented migration rates of adult Chinook salmon ranging from 29 to 32 km per day in the Snake River. Adult Chinook salmon inserted with sonic tags and tracked throughout the Delta and lower Sacramento and San Joaquin rivers were observed exhibiting substantial upstream and downstream movement in a random fashion, several days at a time, while migrating upstream [California Bay-Delta Program (CALFED) 2001]. Adult salmonids migrating upstream are assumed to make greater use of pool and mid-channel habitat than channel margins (Stillwater Sciences 2004), particularly larger salmon such as Chinook salmon, as described by Hughes (2004). Adults are thought to exhibit crepuscular behavior during their upstream migrations, meaning that they are primarily active during twilight hours. Recent hydroacoustic monitoring conducted by LGL Environmental Research Associates showed peak upstream movement of adult Central Valley spring-run Chinook salmon in lower Mill Creek, a tributary to the Sacramento River, occurring in the 4-hour period before sunrise and again after sunset.

Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs, and suitable water temperatures, depths, and velocities for redd construction and adequate oxygenation of incubating eggs. Chinook salmon spawning typically occurs in gravel beds that are located at the tails of holding pools [U.S. Fish and Wildlife Service (USFWS) 1995]. Upon emergence, fry swim or are displaced downstream (Healey 1991). Similar to adult movement, juvenile salmonid downstream movement is crepuscular. Documents and data provided to NMFS in support of ESA section 10 research permit applications depict that the daily migration of juveniles passing RBDD is highest in the 4-hour period prior to sunrise (*e.g.*, Martin *et al.* 2001). Once started downstream, fry may continue downstream to the estuary and rear, or may take up residence in the stream for a period of time from weeks to a year (Healey 1991).

Fry then seek nearshore habitats containing riparian vegetation and associated substrates important for providing aquatic and terrestrial invertebrates, predator avoidance, and slower velocities for resting (NMFS 1996). The benefits of shallow water habitats for salmonid rearing have been found to be more productive than the main river channels, supporting higher growth

rates, partially due to higher prey consumption rates, as well as favorable environmental temperatures (Sommer *et al.* 2001).

As juvenile Chinook salmon grow, they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures (Healey 1991). Catches of juvenile salmon in the Sacramento River near West Sacramento exhibited larger-sized juveniles captured in the main channel and smaller-sized fry along the margins (USFWS 1997). When the river channel is greater than 9 to 10 feet in depth, juvenile salmon tend to inhabit the surface waters (Healey 1980). Stream flow and/or turbidity increases in the upper Sacramento River basin are thought to stimulate emigration (Kjelson *et al.* 1982, Brandes and McLain 2001).

Juvenile Chinook salmon migration rates vary considerably, presumably depending on the physiological stage of the juvenile and hydrologic conditions. Kjelson *et al.* (1982) found fry Chinook salmon to travel as fast as 30 km per day in the Sacramento River and Sommer *et al.* (2001) found rates ranging from approximately 0.5 miles up to more than 6 miles per day in the Yolo Bypass. As Chinook salmon begin the smoltification stage, they prefer to rear further downstream where ambient salinity is up to 1.5 to 2.5 parts per thousand (Healey 1980, Levy and Northcote 1981). Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally-influenced sandy beaches and vegetated zones (Meyer 1979, Healey 1980). Cladocerans, copepods, amphipods, and diptera larvae, as well as small arachnids and ants, are common prey items (Kjelson *et al.* 1982, MacFarlane and Norton 2001, Sommer *et al.* 2001).

Within the estuarine habitat, juvenile Chinook salmon movements are dictated by the tidal cycles, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levy and Northcote 1981, Healey 1991). Kjelson *et al.* (1982) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. During the night, juveniles were distributed randomly in the water column, but would school up during the day into the upper 3 meters of the water column. Juvenile Chinook salmon were found to spend about 40 days migrating through the Sacramento-San Joaquin Delta to the mouth of San Francisco Bay and grew little in length or weight until they reached the Gulf of the Farallone Islands (MacFarlane and Norton 2001). Based on the mainly ocean-type life history observed (*i.e.*, fall-run Chinook salmon), MacFarlane and Norton (2001) concluded that unlike other salmonid populations in the Pacific Northwest, Central Valley Chinook salmon show little estuarine dependence and may benefit from expedited ocean entry.

a. Sacramento River Winter-Run Chinook Salmon

Sacramento River winter-run Chinook salmon were originally listed as threatened in August 1989, under emergency provisions of the ESA, and formally listed as threatened in November 1990 (55 FR 46515). The ESU was reclassified as endangered on January 4, 1994 (59 FR 440), due to increased variability of run sizes, expected weak returns as a result of two small year classes in 1991 and 1993, and a 99 percent decline between 1966 and 1991. NMFS reaffirmed the listing of Sacramento River winter-run Chinook salmon as endangered on June 28, 2005 (70

FR 37160). The ESU consists of only one population that is confined to the upper Sacramento River in California's Central Valley. The Livingston Stone National Fish Hatchery population has been included in the listed Sacramento River winter-run Chinook salmon ESU (June 28, 2005, 70 FR 37160). NMFS designated critical habitat for winter-run Chinook salmon on June 16, 1993 (58 FR 33212).

Sacramento River winter-run Chinook salmon adults enter the Sacramento River basin between December and July, the peak occurring in March (table 1; Yoshiyama *et al.* 1998, Moyle 2002). Spawning occurs primarily from mid-April to mid-August, with the peak activity occurring in May and June in the Sacramento River reach between Keswick Dam and RBDD (Vogel and Marine 1991). The majority of Sacramento River winter-run Chinook salmon spawners are 3 years old.

Emigration of juvenile Sacramento River winter-run Chinook salmon past RBDD may begin as early as mid July, typically peaks in September, and can continue through March in dry years (Vogel and Marine 1991). From 1995 to 1999, all Sacramento River winter-run Chinook salmon outmigrating as fry passed RBDD by October, and all outmigrating pre-smolts and smolts passed RBDD by March (Martin *et al.* 2001). Juvenile Sacramento River winter-run Chinook salmon occur in the Delta primarily from November through early May, based on data collected from trawls in the Sacramento River at West Sacramento [river mile (RM) 57, USFWS 2001]. The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type. Winter-run Chinook salmon juveniles remain in the Delta until they reach a fork length of approximately 118 millimeters (mm) and are from 5 to 10 months of age, and then begin emigrating to the ocean as early as November and continuing through May (Fisher 1994, Myers *et al.* 1998).

Historical Sacramento River winter-run Chinook salmon population estimates were as high as near 100,000 fish in the 1960s, but declined to under 200 fish in the 1990s (Good *et al.* 2005). In recent years, the carcass survey population estimates of winter-run Chinook salmon included in 8,218 in 2003, 7,869 in 2004, 15,839 in 2005, 17,334 in 2006 (CDFG 2008) show a recent increase in the population size and a 4-year average of 12,315. The 2006 run was the highest since the listing. However, the preliminary carcass count of winter-run Chinook salmon in 2007 was only 2,542 (CDFG 2008). The freshwater life history traits and habitat requirements of juvenile winter-run Chinook salmon and fall-run Chinook salmon are similar. Therefore, the unusual and poor ocean conditions that caused the drastic decline in returning fall run Chinook salmon populations coast wide in 2007 (Varanasi and Bartoo 2008) are suspected to have also caused the observed decrease in the winter-run Chinook salmon spawning population in 2007 (Oppenheim 2008). Two current methods are utilized to estimate the juvenile production of Sacramento River winter-run Chinook salmon: the Juvenile Production Estimate (JPE) method, and the Juvenile Production Index (JPI) method (Gaines and Poytress 2004). Gaines and Poytress (2004) estimated the juvenile population of Sacramento River winter-run Chinook salmon exiting the upper Sacramento River at RBDD to be 3,707,916 juveniles per year using the JPI method between the years 1995 and 2003 (excluding 2000 and 2001). Using the JPE method, Gaines and Poytress (2004) estimated an average of 3,857,036 juveniles exiting in the upper Sacramento River at RBDD between the years of 1996 and 2003. Averaging these 2 estimates yields an estimated population size of 3,782,476 juveniles during that time frame.

Based on RBDD counts, the population has been growing rapidly since the 1990s with positive short-term trends. An age-structured density-independent model of spawning escapement by Botsford and Brittnacher (1998) assessing the viability of Sacramento River winter-run Chinook salmon found the species was certain to fall below the quasi-extinction threshold of 3 consecutive spawning runs with fewer than 50 females (Good *et al.* 2005). Lindley and Mohr (2003) assessed the viability of the population using a Bayesian model based on spawning escapement that allowed for density dependence and a change in population growth rate in response to conservation measures. They found a biologically significant expected quasi-extinction probability of 28 percent. Although the status of the Sacramento River winter-run Chinook salmon population is improving, there is only one population, which depends on cold-water releases from Shasta Dam, and could be vulnerable to a prolonged drought (Good *et al.* 2005).

Lindley *et al.* (2007), in their framework for assessing the viability of Chinook salmon and steelhead in the Sacramento-San Joaquin River basin, concluded that the population of winter-run Chinook salmon that spawns below Keswick Dam satisfies low-risk criteria for population size and population decline, but increasing hatchery influence is a concern that puts the population at a moderate risk of extinction. Furthermore, Lindley *et al.* (2007) pointed out that an ESU represented by a single population at moderate risk is at a high risk of extinction over the long term.

b. Central Valley Spring-Run Chinook Salmon

NMFS listed the Central Valley spring-run Chinook salmon ESU as threatened on September 16, 1999 (64 FR 50394). In June 2004, NMFS proposed that Central Valley spring-run Chinook salmon remain listed as threatened (69 FR 33102). This proposal was based on the recognition that although Central Valley spring-run Chinook salmon productivity trends are positive, the ESU continues to face risks from having a limited number of remaining populations (*i.e.*, 3 existing populations from an estimated 17 historical populations), a limited geographic distribution, and potential hybridization with Feather River Hatchery (FRH) spring-run Chinook salmon, which until recently were not included in the ESU and are genetically divergent from other populations in Mill, Deer, and Butte Creeks. On June 28, 2005 (70 FR 37160), after reviewing the best available scientific and commercial information, NMFS issued its final rule to retain the status of Central Valley spring-run Chinook salmon as threatened. This decision also included the FRH spring-run Chinook salmon population as part of the Central Valley spring-run Chinook salmon ESU. Critical habitat was designated for Central Valley spring-run Chinook salmon on September 2, 2005 (70 FR 52488).

Adult Central Valley spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February (CDFG 1998) and enter the Sacramento River between March and September, primarily in May and June (table 2, Yoshiyama *et al.* 1998, Moyle 2002). Lindley *et al.* (2006a) indicated that adult Central Valley spring-run Chinook salmon enter native tributaries from the Sacramento River primarily between mid April and mid June. Typically, spring-run Chinook salmon utilize mid- to high-elevation streams that provide

appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering, while conserving energy and allowing their gonadal tissue to mature (Yoshiyama *et al.* 1998).

Table 1. The temporal occurrence of adult and juvenile Sacramento River winter-run Chinook salmon in the Sacramento River.

Adult Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River basin ¹												
Sacramento River ²												
Juvenile Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River at Red Bluff ³												
Sacramento River at Red Bluff ²												
Sacramento River at Knights Landing ⁴												
Lower Sacramento River (seine) ³												
West Sacramento River (trawl) ⁵												
Relative Abundance:												
	=High	=Medium	=Low									

Sources: ¹ Yoshiyama *et al.* (1998); Moyle (2002); ² Meyers *et al.* (1998); ³ Martin *et al.* (2001); ⁴ Snider and Titus (2000); ⁵ USFWS (2001)

Table 2. The temporal occurrence of adult and juvenile Central Valley spring-run Chinook salmon in the Sacramento River.

Adult Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River basin ^{1,2}												
Sacramento River ³												
Mill Creek ⁴												
Deer Creek ⁴												
Butte Creek ⁴												
Juvenile Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River Tributaries												
Upper Butte Creek												
Mill, Deer, Butte Creeks												
Sacramento River @ RBDD												
Sacramento River @ Knights Landing												
Relative Abundance:												
	=High	=Medium	=Low									

Sources: ¹ Yoshiyama *et al.* (1998); ² Moyle (2002); ³ Meyers *et al.* (1998); ⁴ Lindley *et al.* (2007); ⁵ CDFG (1998); ⁶ McReynolds *et al.* (2005); Ward *et al.* (2002, 2003); ⁷ Snider and Titus (2000)

Spring-run Chinook salmon fry emerge from the gravel from November to March (Moyle 2002), and the emigration timing is highly variable, as they may migrate downstream as young-of-the-year (YOY), juveniles, or yearlings. The modal size of fry migrants at approximately 40 mm between December and April in Mill, Butte, and Deer Creeks reflects a prolonged emergence of fry from the gravel (Lindley *et al.* 2006a). Studies in Butte Creek (Ward *et al.* 2002, 2003; McReynolds *et al.* 2005) found the majority of Central Valley spring-run Chinook salmon migrants to be fry occurring primarily during December through February, and that these movements appeared to be influenced by flow. Small numbers of Central Valley spring-run Chinook salmon remained in Butte Creek to rear and migrated as yearlings later in the spring. Juvenile emigration patterns in Mill and Deer Creeks are very similar to patterns observed in Butte Creek, with the exception that Mill and Deer Creek juveniles typically exhibit a later YOY migration and an earlier yearling migration (Lindley *et al.* 2006a).

Once juveniles emerge from the gravel, they seek areas of shallow water and low velocities while they finish absorbing the yolk sac (Moyle 2002). Many also will disperse downstream during high-flow events. As is the case of other salmonids, there is a shift in microhabitat use by juveniles to deeper, faster water as they grow. Microhabitat use can be influenced by the presence of predators, which can force fish to select areas of heavy cover and suppress foraging in open areas (Moyle 2002). Peak movement of juvenile Central Valley spring-run Chinook salmon in the Sacramento River at Knights Landing occurs in December, and again in March and April. However, juveniles also are observed between November and the end of May (Snider and Titus 2000).

On the Feather River, significant numbers of spring-run Chinook salmon, as identified by run timing, return to FRH. In 2002, FRH reported 4,189 returning spring-run Chinook salmon, which is 22 percent below the 10-year average of 4,727 fish. However, coded-wire tag (CWT) information from these hatchery returns indicates substantial introgression has occurred between fall-run and spring-run Chinook salmon populations within the Feather River system due to hatchery practices. Because Chinook salmon are not temporally separated in the hatchery, spring-run and fall-run Chinook salmon are spawned together, thus compromising the genetic integrity of the spring-run and early fall-run Chinook salmon stocks. The number of naturally-spawning spring-run Chinook salmon in the Feather River has been estimated only periodically since the 1960s, with estimates ranging from 2 fish in 1978 to 2,908 in 1964. However, the genetic integrity of this population is questionable because of the significant temporal and spatial overlap with fall-run Chinook salmon (Good *et al.* 2005). For the reasons discussed above, the Feather River spring-run Chinook population numbers are not included in the following discussion of ESU abundance.

The Central Valley spring-run Chinook salmon ESU has displayed broad fluctuations in adult abundance, ranging from 1,403 in 1993 to 25,890 in 1982. The average abundance for the ESU was 12,590 for the period of 1969 to 1979, 13,334 for the period of 1980 to 1990, 6,554 from 1991 to 2001, and 16,349 between 2002 and 2005 (Pacific Fishery Management Council 2004; CDFG 2004, 2006; Yoshiyama *et al.* 1998). Sacramento River tributary populations in Mill, Deer, and Butte Creeks are probably the best trend indicators for the Central Valley spring-run Chinook ESU as a whole because these streams contain the primary independent populations with the ESU. Generally, these streams have shown a positive escapement trend since 1991.

Escapement numbers are dominated by Butte Creek returns, which have averaged over 7,000 fish since 1995. During this same period, adult returns on Mill Creek have averaged 778 fish, and 1,463 fish on Deer Creek. Although recent trends are positive, annual abundance estimates display a high level of fluctuation, and the overall number of Central Valley spring-run Chinook salmon remains well below estimates of historic abundance. Additionally, in 2003, high water temperatures, high fish densities, and an outbreak of Columnaris Disease (*Flexibacter columnaris*) and Ichthyophthiriasis (*Ichthyophthirius multifiliis*) contributed to the pre-spawning mortality of an estimated 11,231 adult spring-run Chinook salmon in Butte Creek.

Lindley *et al.* (2006a) concluded that Butte and Deer Creek spring-run Chinook salmon are at low risk of extinction, satisfying viability criteria for population size, growth rate, hatchery influence, and catastrophe. The Mill Creek population is at a low to moderate risk, satisfying some, but not all viability criteria. The Feather and Yuba River populations are data deficient and were not assessed for viability. However, because the existing Central Valley spring-run Chinook salmon populations are spatially confined to relatively few remaining streams in only one of four historic diversity groups, the ESU remains vulnerable to catastrophic disturbance, and remains at a moderate to high risk of extinction.

2. Central Valley Steelhead

Central Valley steelhead were originally listed as threatened on March 19, 1998 (63 FR 13347). This DPS consists of steelhead populations in the Sacramento and San Joaquin River basins in California's Central Valley. In June 2004, NMFS proposed that Central Valley spring-run Chinook salmon remain listed as threatened (69 FR 33102). On June 28, 2005, after reviewing the best available scientific and commercial information, NMFS issued its final decision to retain the status of Central Valley steelhead as threatened (70 FR 37160). This decision also included the Coleman National Fish Hatchery and FRH steelhead populations. These populations were previously included in the DPS but were not deemed essential for conservation and thus not part of the listed steelhead population. Critical habitat was designated for Central Valley steelhead on September 2, 2005 (70 FR 52488).

Steelhead can be divided into two life history types, summer-run steelhead and winter-run steelhead, based on their state of sexual maturity at the time of river entry and the duration of their spawning migration, stream-maturing and ocean-maturing. Only winter steelhead are currently found in Central Valley rivers and streams (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the Sacramento river system prior to the commencement of large-scale dam construction in the 1940s [Interagency Ecological Program (IEP) Steelhead Project Work Team 1999]. At present, summer steelhead are found only in northern California coast drainages, mostly in tributaries of the Eel, Klamath, and Trinity River systems (McEwan and Jackson 1996).

Central Valley steelhead generally leave the ocean from August through April (Busby *et al.* 1996), and spawn from December through April, with peaks from January through March, in small streams and tributaries where cool, well oxygenated water is available year-round (table 3, Hallock *et al.* 1961, McEwan and Jackson 1996). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and associated lower water

temperatures. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapovalov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams.

Spawning occurs during winter and spring months. The length of time it takes for eggs to hatch depends mostly on water temperature. Hatching of steelhead eggs in hatcheries takes about 30 days at 51°F. Fry emerge from the gravel usually about 4 to 6 weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can speed or retard this time (Shapovalov and Taft 1954). Newly-emerged fry move to the shallow, protected areas associated with the stream margin (McEwan and Jackson 1996) and they soon move to other areas of the stream and establish feeding locations, which they defend (Shapovalov and Taft 1954).

Steelhead rearing during the summer takes place primarily in higher velocity areas in pools, although YOY also are abundant in glides and riffles. Productive steelhead habitat is characterized by complexity, primarily in the form of large and small woody debris. Cover is an important habitat component for juvenile steelhead both as velocity refugia and as a means of avoiding predation (Meehan and Bjornn 1991).

Juvenile steelhead emigrate episodically from natal streams during fall, winter, and spring high flows. Emigrating Central Valley steelhead use the lower reaches of the Sacramento River and the Delta for rearing and as a migration corridor to the ocean. Juvenile Central Valley steelhead feed mostly on drifting aquatic organisms and terrestrial insects and will also take active bottom invertebrates (Moyle 2002).

Some juvenile steelhead may utilize tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas in the Delta as rearing areas for short periods prior to their final emigration to the sea. Hallock *et al.* (1961) found that juvenile steelhead in the Sacramento River basin migrate downstream during most months of the year, but the peak period of emigration occurred in the spring, with a much smaller peak in the fall. Nobriga and Cadrett (2003) have also verified these temporal findings based on analysis of captures at Chipps Island, Suisun Bay.

Historic Central Valley steelhead run sizes are difficult to estimate given the paucity of data, but may have approached 1 to 2 million adults annually (McEwan 2001). By the early 1960s, the steelhead run size had declined to about 40,000 adults (McEwan 2001). Over the past 30 years, the naturally-spawned steelhead populations in the upper Sacramento River have declined substantially. Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River, upstream of the Feather River. Steelhead counts at RBDD declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations.

Recent estimates from trawling data in the Delta indicate that approximately 100,000 to 300,000 (mean 200,000) smolts emigrate to the ocean per year, representing approximately 3,600 female Central Valley steelhead spawners in the Central Valley basin (Good *et al.* 2005). This can be compared with McEwan's (2001) estimate of 1 million to 2 million spawners before 1850, and 40,000 spawners in the 1960s.





































Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill Creeks and the Yuba River. Populations may exist in Big Chico and Butte Creeks, and a few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996). Recent snorkel surveys (1999 to 2002) indicate that steelhead are present in Clear Creek (Newton 2002 *op. cit.* Good *et al.* 2005). Because of the large resident *O. mykiss* population in Clear Creek, steelhead spawner abundance has not been estimated.

Until recently, Central Valley steelhead were thought to be extirpated from the San Joaquin River system. However, recent monitoring has detected small, self-sustaining populations of steelhead in the Stanislaus, Mokelumne, and Calaveras Rivers, and other streams previously thought to be devoid of steelhead (McEwan 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995 (S.P. Cramer and Associates Inc. 2000).

It is possible that naturally-spawning populations exist in many other streams but are undetected due to lack of monitoring programs (IEP Steelhead Project Work Team 1999). Incidental catches and observations of steelhead juveniles have also occurred on the Tuolumne and Merced Rivers during fall-run Chinook salmon monitoring activities, indicating that steelhead are widespread throughout accessible streams and rivers in the Central Valley (Good *et al.* 2005). CDFG staff have prepared juvenile migrant Central Valley steelhead catch summaries on the San Joaquin River near Mossdale, representing migrants from the Stanislaus, Tuolumne, and Merced Rivers. Based on trawl recoveries at Mossdale between 1988 and 2002, as well as rotary screw trap efforts in all three tributaries, CDFG (2003) stated that it is "clear from this data that rainbow trout do occur in all the tributaries as migrants and that the vast majority of them occur on the Stanislaus River." The documented returns on the order of single fish in these tributaries suggest that existing populations of Central Valley steelhead on the Tuolumne, Merced, and lower San Joaquin Rivers are severely depressed.

Lindley *et al.* (2006) indicated that prior population census estimates completed in the 1990s found the Central Valley steelhead spawning population above RBDD had a fairly strong negative population growth rate and small population size. Good *et al.* (2005) indicated the decline was continuing, as evidenced by new information (Chipps Island trawl data). Central Valley steelhead populations generally show a continuing decline, an overall low abundance, and fluctuating return rates. The future of Central Valley steelhead is uncertain due to limited data concerning their status. However, Lindley *et al.* (2007) concluded that there is sufficient evidence to suggest that the ESU is at moderate to high risk of extinction.

Table 3. The temporal occurrence of adult and juvenile Central Valley steelhead in the Central Valley.

Adult Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River basin ^{1, 2}												
Sacramento River at Red Bluff ^{2, 3}												
Mill, Deer Creeks ⁴												
Sacramento River at Fremont Weir ⁶												
San Joaquin River ⁷												
Juvenile Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River ^{1, 2}												
Sacramento River at Knights Landing ^{2, 8}												
Sacramento River at Knights Landing ⁹												
Chippis Island (wild) ¹⁰												
Mossdale ⁸												
Woodbridge Dam ¹¹												
Stanislaus River at Caswell ¹²												
Sacramento River at Hood ¹³												
Relative Abundance:												
												
												

Sources: ¹ Hallock (1961); ² McEwan (2001); ³ USFWS unpublished data; ⁴ CDFG (1995); ⁵ Hallock *et al.* (1957); ⁶ Bailey (1954); ⁷ CDFG Steelhead Report Card Data; ⁸ CDFG unpublished data; ⁹ Snider and Titus (2000); ¹⁰ Nobriga and Cadrett (2003); ¹¹ Jones & Stokes Associates, Inc. (2002); ¹² S.P. Cramer and Associates, Inc. (2000); ¹³ Schaffter (1980)

3. Southern DPS of North American Green Sturgeon

The Southern DPS of North American green sturgeon was listed as threatened on April 7, 2006, (70 FR 17386) and includes the North American green sturgeon population spawning in the Sacramento River and utilizing the Sacramento River, the Delta, and the San Francisco Estuary. North American green sturgeon are widely distributed along the Pacific Coast and have been documented offshore from Ensenada, Mexico, to the Bering Sea, and found in rivers from British Columbia to the Sacramento River (Moyle 2002). As is the case for most sturgeon, North American green sturgeon are anadromous; however, they are the most marine-oriented of the sturgeon species (Moyle 2002). In North America, spawning populations of the anadromous green sturgeon currently are found in only three river systems, the Sacramento and Klamath Rivers in California and the Rogue River in southern Oregon.

Two green sturgeon DPS', Northern and Southern, were identified based on evidence of spawning site fidelity (indicating multiple DPS tendencies), and on the preliminary genetic evidence that indicates differences at least between the Klamath River and San Pablo Bay samples (Adams *et al.* 2002). The Northern DPS includes all green sturgeon populations starting with the Eel River and extending northward. The Southern DPS would include all green sturgeon populations south of the Eel River,¹ with the only known spawning population being in the Sacramento River.

The Southern DPS of North American green sturgeon life cycle can be divided into four distinct phases based on developmental stage and habitat use: (1) adult females greater than or equal to 13 years of age and males greater than or equal to 9 years of age, (2) juveniles less than or equal to 3 years of age, (3) larvae and post-larvae less than 10 months of age, and (4) coastal migrant females between 3 and 13 years, and males between 3 and 9 years of age (Nakamoto *et al.* 1995, McLain 2006).

New information regarding the migration and habitat use of the Southern DPS of North American green sturgeon has emerged. Lindley (2006) presented preliminary results of large-scale green sturgeon migration studies, and verified past population structure delineations based on genetic work and found frequent large-scale migrations of green sturgeon along the Pacific Coast. It appears North American green sturgeon are migrating considerable distances up the Pacific Coast into other estuaries, particularly the Columbia Estuary. This information also agrees with the results of green sturgeon tagging studies (CDFG 2002), where CDFG tagged a total of 233 green sturgeon in the San Pablo Estuary between 1954 and 2001. A total of 17 tagged fish were recovered: 3 in the Sacramento-San Joaquin Estuary, 2 in the Pacific Ocean off of California, and 12 from commercial fisheries off of Oregon and Washington. Eight of the 12 recoveries were in the Columbia Estuary (CDFG 2002).

Kelley *et al.* (2006) indicated that green sturgeon enter the San Francisco Estuary during the spring and remain until autumn. They studied the movement of adults in the San Francisco

¹ Eel River is a major river system of California draining a rugged area in the California Coast Ranges between the Sacramento Valley and the ocean.

Estuary and found them to make significant long-distance movements with distinct directionality. The movements were not found to be related to salinity, current, or temperature, and Kelley *et al.* (2006) surmised they are related to resource availability. Green sturgeon were most often found at depths greater than 5 meters with low or no current during summer and autumn months (Erickson *et al.* 2002). The majority of green sturgeon in the Rogue River emigrated from freshwater habitat in December after water temperatures dropped (Erickson *et al.* 2002). They surmised that this holding in deep pools was to conserve energy and utilize abundant food resources. Based on captures of adult green sturgeon in holding pools on the Sacramento River above the Glen-Colusa Irrigation District (GCID) diversion (RM 205), the documented presence of adults in the Sacramento River during the spring and summer months, and the presence of larval green sturgeon in late summer in the lower Sacramento River indicating spawning occurrence, it appears adult green sturgeon could utilize a variety of freshwater and brackish habitats for up to 9 months of the year (Beamesderfer 2006).

Adult green sturgeon are believed to feed primarily upon benthic invertebrates such as clams, mysid and grass shrimp, and amphipods (Radtke 1966, Adams *et al.* 2002). Adult sturgeon caught in Washington State waters were found to have fed on Pacific sand lance (*Ammodytes hexapterus*) and callinassid shrimp (Moyle *et al.* 1992).

Based on the distribution of sturgeon eggs, larva, and juveniles in the Sacramento River, CDFG (2002) indicated that the Southern DPS of North American green sturgeon spawn in late spring and early summer above Hamilton City, possibly to Keswick Dam. Adult green sturgeon are believed to spawn every 3 to 5 years and reach sexual maturity only after several years of growth (*i.e.*, 10 to 15 years) based on sympatric white sturgeon sexual maturity (table 4, CDFG 2002). Adult female green sturgeon produce between 60,000 and 140,000 eggs each reproductive cycle, depending on body size, with a mean egg diameter of 4.3 mm (Moyle *et al.* 1992, Van Eenennaam *et al.* 2001). Adults of the Southern DPS of North American green sturgeon begin their upstream spawning migrations into San Francisco Bay in March, reach Knights Landing during April, and spawn between March and July (Heublein 2006). Peak spawning is believed to occur between April and June and thought to occur in deep turbulent pools (Adams *et al.* 2002). Substrate is likely large cobble, but can range from clean sand to bedrock (USFWS 2002). Newly hatched green sturgeon are approximately 12.5 to 14.5 mm in length. According to Heublein (2006), all adults leave the Sacramento River prior to September 1 of each year.

After approximately 10 days, larvae begin feeding, growing rapidly, and young green sturgeon appear to rear for the first 1 to 2 months in the Sacramento River between Keswick Dam and Hamilton City (CDFG 2002). Juvenile green sturgeon first appear in USFWS sampling efforts at RBDD in June and July at lengths ranging from 24 to 31 mm fork length (CDFG 2002, USFWS 2002). The mean yearly total length of post-larval green sturgeon captured in rotary screw traps at the RBDD ranged from 26 mm to 34 mm between 1995 and 2000, indicating they are approximately 2 weeks old. The mean yearly total length of post-larval green sturgeon captured in the GCID rotary screw trap, approximately 30 miles downstream of RBDD, ranged from 33 mm to 44 mm between 1997 and 2005 (CDFG, unpublished data) indicating they are approximately 3 weeks old (Van Eenennaam *et al.* 2001).

Green sturgeon larvae do not exhibit the initial pelagic swim-up behavior characteristic of other *Acipenseridae*. They are strongly oriented to the bottom and exhibit nocturnal activity patterns. Under laboratory conditions, green sturgeon larvae cling to the bottom during the day, and move into the water column at night (Van Eenennaam *et al.* 2001). After 6 days, the larvae exhibit nocturnal swim-up activity (Deng *et al.* 2002) and nocturnal downstream migrational movements (Kynard *et al.* 2005). Juvenile green sturgeon continue to exhibit nocturnal behavior beyond the metamorphosis from larvae to juvenile stages. Kynard *et al.*'s (2005) laboratory studies indicated that juvenile fish continued to migrate downstream at night for the first 6 months of life. When ambient water temperatures reached 46°F, downstream migrational behavior diminished and holding behavior increased. This data suggest that 9-to 10-month-old fish would hold over in their natal rivers during the ensuing winter following hatching, but at a location downstream of their spawning grounds. Juvenile green sturgeon have been salvaged at the Harvey O. Banks Pumping Plant and the John E. Skinner Fish Facility (Fish Facilities) in the South Delta, and captured in trawling studies by CDFG during all months of the year (CDFG 2002). The majority of these fish were between 200 and 500 mm indicating they were from 2 to 3 years of age based on Klamath River age distribution work by Nakamoto *et al.* (1995). The lack of a significant proportion of juveniles smaller than approximately 200 mm in Delta captures indicates juvenile of the Southern DPS of North American green sturgeon likely hold in the mainstem Sacramento River, as suggested by Kynard *et al.* (2005).

Population abundance information concerning the Southern DPS of North American green sturgeon is described in the NMFS status reviews (Adams *et al.* 2002, NMFS 2005a). Limited population abundance information comes from incidental captures of North American green sturgeon from the white sturgeon monitoring program by the CDFG sturgeon tagging program (CDFG 2002). By comparing ratios of white sturgeon to green sturgeon captures, CDFG provides estimates of adult and sub-adult North American green sturgeon abundance. Estimated abundance between 1954 and 2001 ranged from 175 fish to more than 8,000 per year and averaged 1,509 fish per year. Unfortunately, there are many biases and errors associated with these data, and CDFG does not consider these estimates reliable. Fish monitoring efforts at RBDD and GCID on the upper Sacramento River have captured between 0 and 2,068 juvenile North American green sturgeon per year (Adams *et al.* 2002). The only existing information regarding changes in the abundance of the Southern DPS of North American green sturgeon includes changes in abundance at the John E. Skinner Fish Facility between 1968 and 2001. The average number of the Southern DPS of North American green sturgeon taken per year at the State Facility prior to 1986 was 732; from 1986 on, the average per year was 47 (April 7, 2006, 70 FR 17386). For the Harvey O. Banks Pumping Plant, the average number prior to 1986 was 889; from 1986 to 2001 the average was 32 (April 7, 2006, 70 FR 17386). In light of the increased exports, particularly during the previous 10 years, it is clear that the abundance of the Southern DPS of North American green sturgeon is dropping. Additional analysis of North American green and white sturgeon taken at the Fish Facilities indicates that entrainment of both North American green and white sturgeon per acre-foot of water exported has decreased substantially since the 1960s (April 7, 2006, 70 FR 17386). Catches of sub-adult and adult North American green sturgeon by the IEP between 1996 and 2004 ranged from 1 to 212 green sturgeon per year (212 occurred in 2001); however, the portion of the Southern DPS of North American green sturgeon is unknown, as these captures were primarily located in San Pablo Bay, which is known to consist of a mixture of Northern and Southern DPS of North American green

Table 4. The temporal occurrence of adult, larval and post-larval, juvenile, and coastal migrant Southern DPS of North American green sturgeon.

Adult Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(≥13 yrs for females, ≥9 yrs for males)												
Upper Sac River ^{1,2,3}												
SF Bay Estuary ^{4,8}												
Larval / Post-Larval Location (≤10 mos)												
RBDD, Sac River ⁵												
GCID, Sac River ⁵												
Juvenile Location (>10 mos and ≤3 yrs)												
South Delta ^{*6}												
Sac-SJ Delta ⁶												
Sac-SJ Delta ⁵												
Suisun Bay ⁵												
Coastal Migrant Location												
(3-13 yrs for females, 3-9 yrs for males)												
Pacific Coast ^{3,7}												
Relative Abundance:	=High	=Medium	=Low									

Sources: ¹ USFWS (2002); ² Moyle *et al.* (1992); ³ Adams *et al.* (2002) and NMFS (NMFS 2005a); ⁴ Kelley *et al.* (2006); ⁵ CDFG (2002); ⁶ IEP Relational Database, fall midwater trawl green sturgeon captures from 1969 to 2003; ⁷ Nakamoto *et al.* (1995); ⁸ Heublein (2006) *Fish Facility salvage operations

sturgeon. Recent spawning population estimates using sibling-based genetics by Israel (2006) indicate a maximum spawning population of 32 spawners in 2002, 64 in 2003, 44 in 2004, 92 in 2005, and 124 in 2006 above RBDD (with an average of 71). Based on the length and estimated age of post-larvae captured at RBDD (approximately 2 weeks of age) and GCID (downstream; approximately 3 weeks of age), it appears the majority of the Southern DPS of North American green sturgeon are spawning above RBDD. Note, there are many assumptions with this interpretation (*i.e.*, equal sampling efficiency and distribution of post-larvae across channels) and this information should be considered cautiously. While green sturgeon populations were not analyzed in the recent salmonid population viability papers (Lindley *et al.* 2006, 2007) and NMFS' status reviews (Adams *et al.* 2002, NMFS 2005a), the information that is available on green sturgeon indicates that, as with Sacramento River winter-run Chinook salmon, the mainstem Sacramento River may be the last viable spawning habitat for the Southern DPS of North American green sturgeon (NMFS 2003). Lindley *et al.* (2007) pointed out that an ESU represented by a single population at moderate risk is at a high risk of extinction over the long term. Although the extinction risk of the Southern DPS of green sturgeon has not been assessed, NMFS believes that the extinction risk has increased because there is only one population, within the mainstem Sacramento River.

There are at least two records of confirmed adult sturgeon observation in the Feather River (Beamesderfer *et al.* 2004); however, there are no observations of juvenile or larval sturgeon even prior to the 1960s when Oroville Dam was built (NMFS 2005a). There are also unconfirmed reports that green sturgeon may spawn in the Feather River during high flow years (CDFG 2002).

Spawning in the San Joaquin River system has not been recorded, but alterations of the San Joaquin River tributaries (Stanislaus, Tuolumne, and Merced Rivers) and its mainstem occurred early in the European settlement of the region. During the later half of the 1800s, impassable barriers were built on these tributaries where the water courses left the foothills and entered the valley floor. Therefore, these low elevation dams have blocked potentially suitable spawning habitats located further upstream for over a century. Additional destruction of riparian and stream channel habitat by industrialized gold dredging further disturbed any valley floor habitat that was still available for sturgeon spawning. Both white and green sturgeon likely utilized the San Joaquin River basin for spawning prior to the onset of European influence, based on past use of the region by populations of Central Valley spring-run Chinook salmon and Central Valley steelhead. These two populations of salmonids have either been extirpated or greatly diminished in their use of the San Joaquin River basin over the past two centuries.

The freshwater habitat of North American green sturgeon in the Sacramento-San Joaquin drainage varies in function, depending on location. Spawning areas currently are limited to accessible upstream reaches of the Sacramento River. Preferred spawning habitats are thought to contain large cobble in deep, cool pools with turbulent water (CDFG 2002, Moyle 2002).

Migratory corridors are downstream of the spawning areas and include the mainstem Sacramento River and the Delta. These corridors allow the upstream passage of adults and the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams, unscreened or poorly screened diversions, and

degraded water quality. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their 1 to 3 year residence in freshwater. Rearing habitat condition and function may be affected by variation in annual and seasonal flow and temperature characteristics.

B. Critical Habitat and Primary Constituent Elements for Listed Salmonids

The designated critical habitat for Sacramento River winter-run Chinook salmon includes the Sacramento River from Keswick Dam (RM 302) to Chipps Island (RM 0) at the westward margin of the Delta; all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Estuary to the Golden Gate Bridge north of the San Francisco/Oakland Bay Bridge. In the Sacramento River, critical habitat includes the river water column, river bottom, and adjacent riparian zone used by fry and juveniles for rearing. In the areas westward of Chipps Island, critical habitat includes the estuarine water column and essential foraging habitat and food resources used by Sacramento River winter-run Chinook salmon as part of their juvenile emigration or adult spawning migration.

Critical habitat for Central Valley spring-run Chinook salmon includes stream reaches such as those of the Feather and Yuba Rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear Creeks, and the Sacramento River and Delta. Critical habitat for Central Valley steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope Creeks in the Sacramento River basin; and, the San Joaquin River its tributaries, and the Delta.

Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (September 2, 2005, 70 FR 52488). The bankfull elevation is defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series (Dunne and Leopold 1978, MacDonald *et al.* 1991, Rosgen 1996). Critical habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead is defined as specific areas that contain the primary constituent elements (PCE) and physical habitat elements essential to the conservation of the species. Following are the inland habitat types used as PCEs for Central Valley spring-run Chinook salmon and Central Valley steelhead, and as physical habitat elements for Sacramento River winter-run Chinook salmon.

1. Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most spawning habitat in the Central Valley for Chinook salmon and steelhead is located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation. Spawning habitat for Sacramento River winter-run Chinook salmon is restricted to the Sacramento River primarily

between RBDD and Keswick Dam. Central Valley spring-run Chinook salmon also spawn in the mainstem Sacramento River between RBDD and Keswick Dam and in tributaries such as Mill, Deer, and Butte Creeks. Spawning habitat for Central Valley steelhead is similar in nature to the requirements of Chinook salmon, primarily occurring in reaches directly below dams throughout the Central Valley. Most remaining natural spawning habitats (those not downstream from large dams) are currently in good condition, with adequate water temperatures, stream flows, and gravel conditions to support successful reproduction. Some areas below dams, especially for steelhead, are degraded by fluctuating flow conditions related to water storage and flood management that scour or strand redds. Regardless of its current condition, spawning habitat in general has a high intrinsic value, as its function directly affects the spawning success and reproductive potential of listed salmonids.

2. Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover, such as shade, submerged and overhanging large wood, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries may also be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system [e.g., the lower Cosumnes River, Sacramento River reaches with set-back levees (*i.e.*, primarily located upstream of the City of Colusa)]. However, the channeled, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin River system typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Freshwater rearing habitat also has a high intrinsic value to salmonids, as the juvenile life stages are dependant on the function of this habitat for successful survival and recruitment. Thus, although much of the rearing habitat is in poor condition, it is important to the species.

3. Freshwater Migration Corridors

Ideal freshwater migration corridors are free of obstruction with water quantity and quality conditions and contain natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility, survival and food supply. Migratory corridors are downstream of the spawning area and include the lower Sacramento River and the Delta. These corridors allow the upstream passage of adults, and the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams, unscreened or poorly-screened diversions, and degraded water quality. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For adults, upstream passage through the Delta and much of the Sacramento River is not a problem, but problems exist on many tributary streams, and at the RBDD. For juveniles, unscreened or inadequately screen water diversions throughout their migration corridors and a

scarcity of complex in-river cover have degraded this PCE. However, since the primary migration corridors are used by numerous populations, and are essential for connecting early rearing habitat with the ocean, even the degraded reaches are considered to have a high intrinsic value to the species.

4. Estuarine Areas

Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water are included as a PCE. Natural cover, such as submerged and overhanging large wood, aquatic vegetation, and side channels, are suitable for juvenile and adult foraging. The remaining estuarine habitat for these species is severely degraded by altered hydrologic regimes, poor water quality, reductions in habitat complexity, and competition for food and space with exotic species. Regardless of the condition, the remaining estuarine areas are of high intrinsic value because they function as rearing habitat and as an area of transition to the ocean environment.

C. Factors Affecting Listed Species and Critical Habitat

1. Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon, Central Valley Steelhead

California's robust agricultural economy and rapidly increasing urban growth place high demand for water in the Sacramento and San Joaquin River basins. The demand for water in the Central Valley has significantly altered the natural morphology and hydrology of the Sacramento and San Joaquin Rivers and their major tributaries. Agricultural lands and urban areas have flourished on historic floodplains. An extensive flood management system of dams, levees, and bypass channels restricts the river's natural sinuosity, volume, and reduces the lag time of water flowing through the system. An impressive network of water delivery systems have transformed the Central Valley drainage system into a series of lined conveyance channels and reservoirs that are operated by several pumping facilities. Flood management and water delivery systems, in addition to agricultural, grazing, and urban land uses, are the main anthropogenic factors affecting watersheds in the action area.

A number of documents have addressed the history of human activities, present environmental conditions, and factors contributing to the decline of salmon and steelhead species in the Central Valley (*e.g.*, Busby *et al.* 1996, Myers *et al.* 1998, Good *et al.* 2005, CALFED 2000). NMFS has also assessed the factors contributing to Chinook salmon and steelhead decline in supplemental documents (NMFS 1996, 1998) and Federal Register notices (*e.g.*, June 16, 1993, 58 FR 33212; January 4, 1994, 59 FR 440; May 6, 1997, 62 FR 24588; August 18, 1997, 62 FR 43937; March 19, 1998, 63 FR 13347; May 5, 1999, 64 FR 24049; September 16, 1999, 64 FR 50394; February 16, 2000, 65 FR 7764). The foremost reason for the decline in these anadromous salmonid and green sturgeon populations is the degradation and/or destruction of habitat (*e.g.*, substrate, water quality, water quantity, water temperature, water velocity, shelter, food, riparian vegetation, and migration conditions). Additional factors contributing to the decline of these populations include: over-utilization, disease or predation, the inadequacy of existing regulatory mechanisms, and other natural and manmade factors including habitat and

ecosystem restoration, and global climate change. All of these factors have contributed to the ESA-listing of these fish and deterioration of their critical habitats. However, it is widely recognized in numerous species accounts in the peer-reviewed literature that the modification and curtailment of habitat and range have had the most substantial impacts on the abundance, distribution, population growth, and diversity of salmonid ESUs and DPSs. Although habitat and ecosystem restoration has contributed to recent improvements in habitat conditions throughout the ESUs/DPSs, global climate change remains a looming threat.

a. Modification and Curtailment of Habitat and Range

Modification and curtailment of habitat and range from hydropower, flood control, and consumptive water use have permanently blocked or hindered salmonid access to historical spawning and rearing grounds, resulting in the complete loss of substantial portions of spawning, rearing, and migration PCEs. Clark (1929) estimated that there were originally 6,000 linear miles of salmon habitat in the Central Valley system, and that 80 percent of this habitat had been lost by 1928. Yoshiyama *et al.* (1996) calculated that roughly 2,000 linear miles of salmon habitat was actually available before dam construction and mining, and concluded that 82 percent is not accessible today. Yoshiyama *et al.* (1996) surmised that steelhead habitat loss was even greater than salmon loss, as steelhead migrated farther into drainages. In general, large dams on every major tributary to the Sacramento River, San Joaquin River, and the Delta block salmon and steelhead access to the upper portions of their respective watersheds. The loss of upstream habitat had required Chinook salmon and steelhead to use less hospitable reaches below dams. The loss of substantial habitat above dams also has resulted in decreased juvenile and adult steelhead survival during migration, and in many cases, had resulted in the dewatering and loss of important spawning and rearing habitats.

The diversion and storage of natural flows by dams and diversion structures on Central Valley waterways have depleted stream flows and altered the natural cycles by which juvenile and adult salmonids have evolved. Changes in stream flows and diversions of water affect spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine habitat PCEs. As much as 60 percent of the natural historical inflow to Central Valley watersheds and the Delta have been diverted for human uses. Depleted flows have contributed to higher temperatures, lower dissolved oxygen (DO) levels, and decreased recruitment of gravel and instream woody material. More uniform flows year-round have resulted in diminished natural channel formation, altered food web processes, and slower regeneration of riparian vegetation. These stable flow patterns have reduced bedload movement, caused spawning gravels to become embedded, and decreased channel widths due to channel incision, all of which has decreased the available spawning and rearing habitat below dams.

Water withdrawals, for agricultural and municipal purposes have reduced river flows and increased temperatures during the critical summer months, and in some cases, have been of a sufficient magnitude to result in reverse flows in the lower San Joaquin River (Reynolds *et al.* 1993). Direct relationships exist between water temperature, water flow, and juvenile salmonid survival (Brandes and McLain 2001). High water temperatures in the Sacramento River have limited the survival of young salmon.

The development of the water conveyance system in the Delta has resulted in the construction of more than 1,100 miles of channels and diversions to increase channel elevations and flow capacity of the channels (Mount 1995). Levee development in the Central Valley affects spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine habitat PCEs. The construction of levees disrupts the natural processes of the river, resulting in a multitude of habitat-related effects that have diminished conditions for adult and juvenile migration and survival.

Many of these levees use angular rock (riprap) to armor the bank from erosive forces. The effects of channelization and riprapping include the alteration of river hydraulics and cover along the bank as a result of changes in bank configuration and structural features (Stillwater Sciences 2006). These changes affect the quantity and quality of nearshore habitat for juvenile salmonids and have been thoroughly studied (USFWS 2000, Schmetterling *et al.* 2001, Garland *et al.* 2002). Simple slopes protected with rock revetment generally create nearshore hydraulic conditions characterized by greater depths and faster, more homogeneous water velocities than occur along natural banks. Higher water velocities typically inhibit deposition and retention of sediment and woody debris. These changes generally reduce the range of habitat conditions typically found along natural shorelines, especially by eliminating the shallow, slow-velocity river margins used by juvenile fish as refuge and escape from fast currents, deep water, and predators (Stillwater Sciences 2006).

Large quantities of downed trees are a functionally important component of many streams (NMFS 1996). Large woody debris influences channel morphology by affecting longitudinal profile, pool formation, channel pattern and position, and channel geometry. Downstream transport rates of sediment and organic matter are controlled in part by storage of this material behind large wood. Large wood affects the formation and distribution of habitat units, provides cover and complexity, and acts as a substrate for biological activity (NMFS 1996). Wood enters streams inhabited by salmonids either directly from adjacent riparian zones or from riparian zones in adjacent non-fish bearing tributaries. Removal of riparian vegetation and instream woody material from the streambank results in the loss of a primary source of overhead and instream cover for juvenile salmonids. The removal of riparian vegetation and instream woody material and the replacement of natural bank substrates with rock revetment can adversely affect important ecosystem functions. Living space and food for terrestrial and aquatic invertebrates is lost, eliminating an important food source for juvenile salmonids. Loss of riparian vegetation and soft substrates reduces inputs of organic material to the stream ecosystem in the form of leaves, detritus, and woody debris, which can affect biological production at all trophic levels.

In addition, the armoring and revetment of stream banks tends to narrow rivers, reducing the amount of habitat per unit channel length (Sweeney *et al.* 2004). As a result of river narrowing, benthic habitat decreases and the number of macroinvertebrates, such as stoneflies and mayflies, per unit channel length decreases affecting salmonid food supply.

b. Ecosystem Restoration

The Central Valley “practicably irrigable acreage” (PIA), implemented in 1992, requires that fish and wildlife get equal consideration with other demands for water allocations derived from the

Central Valley PIA. From this act arose several programs that have benefited listed salmonids: the Anadromous Fish Restoration Program (AFRP), the Anadromous Fish Screen Program (AFSP), and the Water Acquisition Program (WAP). The AFRP is engaged in monitoring, education, and restoration projects geared toward doubling the natural populations of select anadromous fish species residing in the Central Valley. Restoration projects funded through the AFRP include fish passage, fish screening, riparian easement and land acquisition, development of watershed planning groups, instream and riparian habitat improvement, and gravel replenishment. The AFSP combines Federal funding with State and private funds to prioritize and construct fish screens on major water diversions mainly in the upper Sacramento River. The goal of the WAP is to acquire water supplies to meet the habitat restoration and enhancement goals of the Central Valley PIA and to improve the Department of the Interior's ability to meet regulatory water quality requirements. Water has been used successfully to improve fish habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead by maintaining or increasing instream flows in Butte and Mill Creeks and the San Joaquin River at critical times.

Two programs included under CALFED; the Ecosystem Restoration Program (ERP) and the Environmental Water Account, were created to improve conditions for fish, including listed salmonids, in the Central Valley. Restoration actions implemented by the ERP include the installation of fish screens, modification of barriers to improve fish passage, habitat acquisition, and instream habitat restoration. The majority of these actions address key factors affecting listed salmonids, and emphasis has been placed in tributary drainages with high potential for Central Valley steelhead and spring-run Chinook salmon production. Additional ongoing actions include new efforts to enhance fisheries monitoring and directly support salmonid production through hatchery releases. Recent habitat restoration initiatives sponsored and funded primarily by the CALFED-ERP have resulted in plans to restore ecological function to 9,543 acres of shallow-water tidal and marsh habitats within the Delta. Restoration of these areas primarily involves flooding lands previously used for agriculture, thereby creating additional rearing habitat for juvenile salmonids.

The California Department of Water Resources' (CDWR) Four Pumps Agreement Program has approved approximately \$49 million for projects that benefit salmon and steelhead production in the Sacramento-San Joaquin basins and Delta since the agreement's inception in 1986. Four Pumps projects that benefit Central Valley spring-run Chinook salmon and steelhead include water exchange programs on Mill and Deer Creeks; enhanced law enforcement efforts from San Francisco Estuary upstream to the Sacramento and San Joaquin Rivers and their tributaries; design and construction of fish screens and ladders on Butte Creek; and screening of diversions in Suisun Marsh and San Joaquin tributaries. Additionally, predator habitat isolation and removal and spawning habitat enhancement projects on the San Joaquin tributaries benefit steelhead.

c. Natural Conditions/Climate Change

Natural changes in the freshwater and marine environments play a major role in salmonid and green sturgeon abundance. Recent evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Hare *et al.* 1999, Mantua and Hare 2002). This phenomenon has been referred to as the Pacific

Decadal Oscillation. In addition, large-scale climatic regime shifts, such as El Niño, appear to change ocean productivity. During the first part of the 1990s, much of the Pacific Coast was subject to a series of very dry years.

The world is about 1.3°F warmer today than a century ago and the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century (Intergovernmental Panel on Climate Change 2001). Much of that increase will likely occur in the oceans, and evidence suggests that the most dramatic changes in ocean temperature are now occurring in the Pacific (Noakes 1998). Using objectively analyzed data, Huang and Liu (2000) estimated a warming of about 0.9°F per century in the Northern Pacific Ocean.

An alarming prediction is the fact that Sierra snow packs are expected to decrease with global warming and that the majority of runoff in California will be from rainfall in the winter rather than from melting snow pack in the mountains (CDWR 2006). This will alter river runoff patterns and transform the tributaries that feed the Central Valley from a spring/summer snowmelt-dominated system to a winter rain dominated system. This would likely truncate the period of time that suitable cold-water conditions exist below existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold-water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall temperatures below reservoirs, such as Lake Shasta, could rise above thermal tolerances for juvenile and adult salmonids (*e.g.*, Sacramento River winter-run Chinook salmon and Central Valley steelhead) that must hold below Keswick Dam over the summer and fall periods.

Another key factor affecting many West Coast fish stocks has been a general 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood, partially because the pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. NMFS presumes that survival is driven largely by events occurring between ocean entry and recruitment to a subadult life stage. One indicator of early ocean survival can be computed as a ratio of CWT recoveries from subadults relative to the number of CWTs released from that brood year.

Salmon and steelhead are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Ocean predation may also contribute to significant natural mortality, although to what degree is not known. In general, salmonids are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that the rebound of seal and sea lion populations—following their protection under the Marine Mammal Protection Act of 1972—has substantially increased salmonid mortality.

Finally, the unusual drought conditions in 2001 warrant additional consideration. Flows in 2001 were among the lowest flow conditions on record. The available water in the Sacramento and San Joaquin River watersheds was 70 percent and 66 percent of normal, according to the Sacramento River Index and the San Joaquin River Index, respectively. The juveniles that

passed downriver during the 2001 spring and summer out migration were likely affected, and this, in turn, likely affected adult returns primarily in 2003 and 2004, depending on the stock and species.

d. Southern DPS of North American Green Sturgeon

The principal factors for the decline in the Southern DPS of North American green sturgeon are reviewed in the proposed listing notice (April 6, 2005, 70 FR 17386) and status reviews (Adams *et al.* 2002, NMFS 2005a), and primarily consist of: (1) the present or threatened destruction, modification, or curtailment of habitat or range; (2) poor water quality; (3) over-utilization; (4) increased water temperatures; (5) non-native species; and (6) other natural and manmade factors, including habitat and ecosystem restoration, and global climate change.

NMFS (2005a) concluded that the principle threat to green sturgeon is impassible barriers, primarily Keswick and Shasta Dams on the Sacramento River and Feather River that likely block and prevent access to historic spawning habitat (NMFS 2005a). Spawning habitat may have extended up into the three major branches of the Sacramento River; the Little Sacramento River, the Pit River system, and the McCloud River (NMFS 2005a). In contrast, recent modeling evaluations by Mora (2006) indicate little or no habitat in the Little Sacramento River or the Pit River exists above Shasta Dam; however, a considerable amount of habitat exists above Shasta on the mainstem Sacramento River. Green and white sturgeon adults have been observed periodically in the Feather and Yuba Rivers (USFWS 1995, Beamesderfer *et al.* 2004, McLain 2006), and habitat modeling by Mora (2006) suggests there is sufficient habitat above Oroville Dam. There are no records of larval or juvenile white or green sturgeon; however, there are reports that green sturgeon may reproduce in the Feather River during high flow years (CDFG 2002), but these are unconfirmed.

No green sturgeon have been observed in the San Joaquin River; however, the presence of white sturgeon has been documented (USFWS 1995, Beamesderfer *et al.* 2004), making green sturgeon presence historically likely, as the two species require similar habitat and their ranges overlap in the Sacramento River. Habitat modeling by Mora (2006) also suggests sufficient conditions are present in the San Joaquin River to Friant Dam, and in the Stanislaus, Tuolumne, and Merced Rivers to their respective dams. In addition, the San Joaquin River had the largest spring-run Chinook salmon population in the Central Valley prior to the construction of Friant Dam (Yoshiyama *et al.* 2001) with escapements approaching 500,000 fish. Thus, based on prior spring-run Chinook salmon distribution and habitat use in the San Joaquin River, it is very possible that green sturgeon were extirpated from the San Joaquin River basin in a similar manner to spring-run Chinook salmon. The loss of potential green sturgeon spawning habitat on the San Joaquin River also may have contributed to the overall decline of the Southern DPS of North American green sturgeon.

The potential effects of climate change were discussed in the Chinook salmon and Central Valley steelhead sections and primarily consist of altered ocean temperatures and stream flow patterns in the Central Valley. Changes in Pacific Ocean temperatures can alter predator-prey relationships and affect migratory habitat of the Southern DPS of North American green sturgeon. Increases in rainfall and decreases in snow pack in the Sierra Nevada range will affect

cold-water pool storage in reservoirs affecting river temperatures. As a result, the quantity and quality of water that may be available to the Southern DPS of North American green sturgeon will likely significantly decrease.

e. Critical Habitat for Salmonids

According to NMFS' (2005b) Critical Habitat Analytical Review Team (CHART) report, the major categories of habitat-related activities affecting Central Valley salmonids include: (1) irrigation impoundments and withdrawals, (2) channel modifications and levee maintenance, (3) the presence and operation of hydroelectric dams, (4) flood control and streambank stabilization, and (5) exotic and invasive species introductions and management. All of these activities affect PCEs via their alteration of one or more of the following: stream hydrology, flow and water-level modification, fish passage, geomorphology and sediment transport, temperature, DO levels, nearshore and aquatic vegetation, soils and nutrients, physical habitat structure and complexity, forage, and predation (Spence *et al.* 1996). According to the CHART report (NMFS 2005b), the condition of critical habitat varies throughout the range of the species. Generally, the conservation value of existing spawning habitat ranges from moderate to high quality, with the primary threats including changes to water quality, and spawning gravel composition from rural, suburban, and urban development, forestry, and road construction and maintenance. Downstream, river and estuarine migration and rearing corridors range in condition from poor to high quality depending on location. Tributary migratory and rearing corridors tended to rate as moderate quality due to threats to adult and juvenile life stages from irrigation diversion, small dams, and water quality. Delta (*i.e.*, estuarine) and mainstem Sacramento and San Joaquin River reaches tended to range from poor to high quality, depending on location. In the alluvial reach of the Sacramento River between Red Bluff and Colusa, the PCEs of rearing and migration habitat are in good condition because, despite the influence of upstream dams, this reach retains natural, and functional channel processes that maintain and develop anadromous fish habitat. The river reach downstream from Colusa and including the Delta is poor in quality due to impaired hydrologic conditions from dam operations, water quality from agriculture, degraded nearshore and riparian habitat from levee construction and maintenance, and habitat loss and fragmentation.

IV. ENVIRONMENTAL BASELINE

The environmental baseline "includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation process" (50 CFR 402.02). As stated in section II.D, "Action Area," of this biological opinion, the action area encompasses: (1) the lateral 200 feet of the Sacramento River beginning at the right bank, from 200 feet upstream of the Mill Site construction area to 500 feet downstream of RBDD. This area was selected because it represents the upstream and lateral extents of anticipated acoustic effects from pile driving, and downstream extent of anticipated effects related to increases in suspended sediment and turbidity. The length of this reach is relatively short and totals approximately 3,750 feet; and (2) Red Bank Creek, from the proposed

location of the bridge, downstream approximately 600 feet to the confluence of the Sacramento River.

1. Status of Listed Species and Critical Habitat within the Action Area

The action area provides adult spawning and juvenile rearing habitat, and functions as a migratory corridor for adult and juvenile winter- and spring-run Chinook salmon, Central Valley steelhead, and Southern DPS of North American green sturgeon. Due to the life history timing of winter- and spring-run Chinook salmon, steelhead and North American green sturgeon, it is possible for one or more of the following life stages to be present within the action area throughout the year: adult migrants, spawners, incubating eggs, or rearing and emigrating juveniles.

a. Status of the Species in the Action Area

(1) Chinook Salmon. CDFG conducts frequent aerial redd surveys of the upper Sacramento River from Princeton Ferry to Keswick Dam throughout the year. Records were examined for the reaches extending from RBDD upstream to Bend Bridge, and from RBDD downstream to the Tehama Bridge, for the period from 2001 through 2007. These surveys indicate that the action area is within the spawning range of winter- and spring-run Chinook salmon, however, they suggest that limited spawning occurs within the action area. Most spring-run Chinook salmon, including all 3 independent populations, spawn downstream of the action area and will not be affected by the proposed project. Although the CDFG surveys are not of sufficient precision or uniform frequency to allow accurate quantification of the number of redds historically observed in the immediate vicinity of RBDD, the following general statements can be made. Most redds were present between October 1 and December 31, indicating that they were most likely created by fall-run and late fall-run Chinook salmon (non-listed species). A total of 3,546 redds were recorded in the combined reaches upstream and downstream of RBDD; of these, less than 1 percent (29) were built during the time period when winter-run Chinook salmon would be expected to be spawning, or the period exclusive to spring-run spawning (September). Most spawning in the action area occurs just downstream of RBDD. The gravel bar located at the mouth of Red Bank Creek just upstream of RBDD is also a likely spawning area during periods when the RBDD gates are open (Tucker 2007). Current operation of RBDD results in the presence of Lake Red Bluff extending upstream from RBDD during the period from May 15 through September 15, which would preclude most spawning in this portion of the action area by winter- and spring- run Chinook salmon.

(2) Central Valley Steelhead. Central Valley steelhead populations currently spawn in tributaries to the Sacramento and San Joaquin Rivers. The proportion of steelhead in this DPS that migrate through the action area is unknown. However, because of the relatively large amount of suitable habitat in the Sacramento River relative to the San Joaquin River, the proportion is probably high. Adult steelhead may be present throughout the action area from June through March, with the peak occurring between August and October (Bailey 1954, Hallock *et al.* 1957). Juvenile steelhead emigrate through the Sacramento River from late fall to spring. Snider and Titus (2000) observed that juvenile steelhead emigration primarily occurs between November and May at Knights Landing. The majority of juvenile steelhead emigrate as

yearlings and are assumed to primarily utilize the center of the channel rather than the shoreline. Central Valley steelhead and/or rainbow trout redds have been observed within the action area during aerial redd surveys, although these redds have not been counted or documented (Killam 2005).

(3) Southern DPS of North American Green Sturgeon. The spawning population of the Southern DPS of North American green sturgeon is currently restricted to the Sacramento River below Keswick Dam, and is composed of a single breeding population, thus the entire population of adults and juveniles must pass through the action area. Adult green sturgeon were video documented immediately below RBDD in 2004 (Killam 2005). During the period of an emergency RBDD gate closure from May 3-9, 2007, adult green sturgeon were observed staging (*i.e.*, for upstream migration) on the downstream side of the dam (Corwin 2007). Newly hatched juvenile green sturgeon are captured each summer in the rotary screw traps which sample the water coming out of RBDD (Gaines and Martin 2002) providing firm evidence that spawning occurs upstream of RBDD.

b. Status of Critical Habitat in the Action Area

(1) Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon, and Central Valley Steelhead. The action area is within designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon and Central Valley steelhead. Habitat requirements for these species are similar. The PCEs of salmonid habitat within the action area include: freshwater rearing habitat and freshwater migration corridors, containing adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food; riparian vegetation, space, and safe passage conditions. Habitat within the action area is primarily used as adult and juvenile migration and juvenile rearing. The condition and function of this habitat has been severely impaired through several factors discussed in section III.C, "Factors Affecting Listed Species and Critical Habitat," of this biological opinion. The result has been the reduction in quantity and quality of several essential elements of migration and rearing habitat required by juveniles to grow and survive. In spite of the degraded condition of this habitat, it remains extremely important to the survival of the listed salmonids because its entire length is used for extended periods of time by a large proportion of all Federally-listed anadromous fish species that spawn in the upper Sacramento River and its tributaries above RBDD.

The greatest impacts to the PCEs of critical habitat within the action area are related to the construction and operation of RBDD and its associated diversion facilities. Large amounts of concrete and sheet piling dominate the habitat features within the action area. The dam and diversion complex impact the PCEs of spawning (through inundation of potential spawning habitat upstream of the dam), migration (through blockage of upstream migrants and entrainment of downstream migrants), and rearing (by reducing the complexity of near-shore habitats and creating unnatural advantages to piscivorous predators around the manmade structures).

The river bank and riparian zone along the Mill Site has also been heavily impacted by RBDD operations. Frequent inundation and draining of the area caused by lowering and raising of the RBDD gates has left much of this shoreline nearly devoid of vegetation. During gates-out (free

flowing) conditions, this shoreline consists of a nearly vertical 10- to 20-foot tall adobe clay bank with little or no vegetation near the water's edge. When the RBDD gates are lowered and the lake is formed (and during high winter flow events), the water level rises to a point where the sparse riparian vegetation along the top of the bank may have some contact with, and provide some shading to, the water line.

The diversion and storage of natural flows by dams and diversion structures on Central Valley waterways have depleted streamflows and altered the natural cycles by which juvenile and adult salmonids have evolved. Changes in streamflows and diversions of water affect freshwater rearing habitat and freshwater migration corridor PCEs in the action area. Various land-use activities in the action area, such as urbanization and agricultural encroachment, have resulted in habitat simplification. Runoff from residential and industrial areas also contributes to water quality degradation [California Regional Water Quality Control Board (CRWQCB)-Central Valley Region 1998]. Urban stormwater runoff contains pesticides, oil, grease, heavy metals, polycyclic aromatic hydrocarbons, other organics and nutrients (CRWQCB-Central Valley Region 1998) that contaminate drainage waters and destroy aquatic life necessary for salmonid survival (NMFS 1996). In addition, juvenile salmonids are exposed to increased water temperatures as a result of thermal inputs from municipal, industrial, and agricultural discharges in the action area. Increased predation as a result of habitat changes in the action area, such as the alteration of natural flow regimes and the installation of bank revetment structures, is likely a factor in the decline of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead.

Within the action area, the freshwater rearing and migration PCEs have been transformed from a meandering waterway lined with a dense riparian corridor, to a highly leveed system under varying degrees of control over riverine erosional processes and flooding.

(2) Southern DPS of North American Green Sturgeon. The majority of the action area is utilized by the Southern DPS of North American green sturgeon adults for holding and migration. North American green sturgeon holding habitat consists of the bottoms of deep pools where velocities are lowest, often in off-channel coves or low-gradient reaches of the main channel (Erickson *et al.* 2002). Erickson *et al.* (2002) also found many of these sites were close to sharp bends in the Rogue River.

The diversions in the action area are a potential threat to the Southern DPS of North American green sturgeon. Larval green sturgeon are likely susceptible to entrainment primarily from benthic water diversion facilities during the first 5 days of development and susceptible to diversion entrainment from facilities drawing water from the bottom and top of the water column starting at day 6. Reduced flows in the action area likely affect year class strength of the Southern DPS of North American green sturgeon as increased flows have been found to improve year class strength. Various land-use activities in the action area, such as urbanization and agricultural encroachment, have resulted in habitat simplification. Runoff from residential and industrial areas also contributes to water quality degradation (CRWQCB-Central Valley Region 1998). Urban stormwater runoff contains pesticides, oil, grease, heavy metals, polycyclic aromatic hydrocarbons, other organics and nutrients (CRWQCB-Central Valley Region 1998) that contaminate drainage waters and destroy aquatic life necessary for green sturgeon survival

(NMFS 1996). In addition, juvenile and adult green sturgeon are exposed to increased water temperatures as a result of thermal inputs from municipal, industrial, and agricultural discharges in the action area.

The transformation of the Sacramento River from a meandering waterway lined with dense riparian corridor, to a highly leveed system under varying degrees of control over riverine erosional processes resulted in homogenization of the river, including effects to the river's sinuosity (USFWS 2000). In addition, the change in the ecosystem as a result of the removal of riparian vegetation and instream woody material likely impacted potential prey items and species interaction that green sturgeon would experience while holding. The effects of channelization on upstream migration of green sturgeon are unknown.

The action area is utilized by larvae and post-larvae and to a lesser extent, juvenile Southern DPS of North American green sturgeon for rearing and migration purposes. Although it is believed that larvae and post-larvae as well as juveniles primarily are benthically oriented (with the exception of the post-larvae nocturnal swim-up believed to be a dispersal mechanism), channelization in the action area has resulted in a loss of ecosystem properties (USFWS 2000, Sweeney *et al.* 2004). Channelization results in reduced food supply (aquatic invertebrates) and reduced pollutant processing, organic matter processing, and nitrogen uptake (Sweeney *et al.* 2004).

2. Factors Affecting Listed Species and Critical Habitat within the Action Area

Current operation of RBDD under the OCAP biological opinion (NMFS 2004) includes a 4-month period (mid-May through mid-September) when the dam gates are placed in the river. During gates-in periods, juvenile life stages of all anadromous salmonids migrate downstream (emigrate) past RBDD under the dam gates, through the fish ladders and their auxiliary water systems, or are subjected to entrainment and passage through diversion bypass systems at the RPP and TCC headworks. The most significant threat to the juvenile salmonids passing through the action area are the direct losses related to passing under the RBDD gates and subsequent predation by Sacramento River pikeminnows and striped bass that congregate immediately below the dam. Additionally, predation by avian and fish species within Lake Red Bluff might be a significant threat to all juvenile life stages in the vicinity of RBDD. When the gates are in the river, velocity barriers and whitewater turbulence are created that prevent adult Chinook salmon and steelhead from passing upstream of the dam, except through fish ladders located on the east and west ends and at the center of RBDD. These ladders are undersized and are not very successful in passing adult salmonids without delays.

Under current operations, approximately 15 percent of winter-run Chinook salmon adult spawners passing through the action area might be blocked or delayed by the current 4-month period when the dam gates are in operation. Adult Central Valley spring-run Chinook salmon are also significantly affected by RBDD operations. Approximately 10 percent of adult spring-run Chinook salmon spawn upstream of RBDD. Of those, approximately 75 percent pass through the action area during the current gates-in operation. Impedance of these adult spring-run Chinook salmon by RBDD operations might adversely affect their ability to successfully migrate into tributary stream and headwater reaches upstream of RBDD. It is challenging to

characterize the temporal distribution of adult winter- and spring-run Chinook salmon as they pass RBDD because before mid-May, the gates-out operations at RBDD preclude the use of the fish ladders and, therefore, the enumeration of adults as they pass RBDD. However, after the RBDD gates go in during May, Chinook salmon are identified as they pass. Up to 25 percent of the annual run of adult Central Valley fall-run Chinook salmon might be affected by the current gates-in operation (CH2MHill 2007). Currently, adult late-fall-run Chinook salmon pass unimpeded at RBDD because they immigrate during the period (October through March) when the RBDD gates are out of the river.

For migrating adult steelhead, approximately 17 percent of the annual adult steelhead run might be affected by the current gates-in operation. Approximately 36 percent of juvenile steelhead passing RBDD are subject to operational impacts during the gates-in period.

When the dam gates are placed in the river, a physical barrier is created that prevents passage of adult sturgeon, as green sturgeon are not known to successfully use the fish ladders at RBDD (Brown 2002). Currently, a large portion of the adult green sturgeon successfully pass RBDD unimpeded because they are immigrating during the period before May 15 when the gates go in. Under current operations, approximately 35 percent of adult green sturgeon spawners passing through the action area might be blocked by RBDD. In addition, some adult green sturgeon might be delayed in their down-river migration by RBDD after spawning occurs upstream of the dam before May 15 if these fish arrive at RBDD on or after May 16 when the dam gates are placed in the river. With the current gates-in operations, approximately 99 percent of annual green sturgeon larvae/post-larvae passing RBDD are subjected to the operational effects of the dam and its associated diversion facilities.

Ongoing improvements to the upper reaches of the Sacramento River, including gravel augmentation, screening of diversions, and riparian habitat restoration, are expected to further improve conditions for anadromous fish and critical habitat, but the incremental benefit of these actions is not yet known. Even with these improvements, some problems persist that may affect anadromous fish and reduce the quality of the PCEs of critical habitat within the action area. Some of the remaining problems include episodic discharges of heavy metals from the Iron Mountain Mine Superfund site, major fall and winter flow reductions causing dewatering of redds, potential competition and genetic introgression between spring- and fall-run Chinook salmon due to overlapping spawning habitats, and degraded rearing conditions in the river due to a lack of mature riparian habitat.

The frequency of acid mine drainage exceeding target levels below Keswick Dam has decreased over the last 10 years; however, exceedences of dissolved copper targets have occurred during each of the last 6 years, and metal concentrations remain high enough to have sublethal effects on adult fish and lethal effects on eggs and larvae (CRWQCB 2001). Although acid mine drainage has, over the years, reduced the number of Chinook salmon and steelhead within the action area, recent remedial actions at Iron Mountain Mine are thought to have curtailed the direct poisoning of listed species.

Fall flow reductions have been found to negatively impact PCEs for salmonid spawning by causing extensive redd dewatering throughout the Sacramento River spawning areas (Killam

2002). The largest reductions have been occurring in early to mid-November, following the peak in water demand for rice decomposition. While reductions in this time period primarily impact fall-run Chinook salmon, they also have the potential to impact late spawning spring-run Chinook salmon and early spawning steelhead.

The construction of Shasta and Keswick Dams, and the resultant exclusion of spring-run Chinook salmon from their historic upper Sacramento River spawning habitat has forced mainstem-spawning spring-run Chinook salmon to spawn in the middle reaches of the river (between Keswick and Red Bluff Dams) in areas easily accessible to fall-run Chinook salmon. Because spring-run Chinook salmon hold over the summer and spawn during a similar time period as do fall-run Chinook salmon (September through October depending on habitat conditions), there is a potential for the two species to have negative interactions such as competition for prime spawning sites, superimposition of redds in the same location, and genetic introgression caused by individuals of the different races spawning together and creating crossed progeny.

3. Importance of the Action Area to the Survival and Recovery of Listed Species

Winter- and spring-run Chinook salmon, steelhead and green sturgeon are expected to continue to utilize the action area as a migratory corridor and for spawning and rearing. Despite its relatively small size, the value of the action area as a migratory corridor, and its suitability as spawning and rearing habitat, make it an important node of habitat for the survival and recovery of local populations of listed species. Because the action area is within the most important habitat available to winter-run Chinook salmon, the continuity and connectivity of the action area to the rest of their habitat is important for the survival and recovery of that ESU.

The information that is available on green sturgeon indicates that, as with winter-run Chinook salmon, the mainstem Sacramento River may be the last viable spawning habitat for the Southern DPS of North American green sturgeon (NMFS 2003). Because of similarities in their migration and spawn timing, it is likely that many of the same factors affecting winter-run Chinook salmon are also significant to green sturgeon. Because the action area is within the most important habitat available to the Southern DPS of North American green sturgeon, the continuity and connectivity of the action area to the rest of their habitat is important for the survival and recovery of that DPS.

Although the habitat within the action area may be important for the survival and recovery of local and upstream populations of spring-run Chinook salmon, the primary abundance of spring-run Chinook salmon in streams and rivers downstream of the action area, means that the value of the habitat within the action area may not be as essential for the survival and recovery of spring-run Chinook salmon as it is for winter- run and green sturgeon.

The Central Valley steelhead DPS' dependence on the action area is intermediate between that of winter- run and spring-run Chinook salmon. Like spring-run Chinook salmon, a significant proportion of the Central Valley steelhead DPS spawn downstream of the action area, although their population numbers are more evenly distributed upstream and downstream of RBDD than are spring-run Chinook salmon, and large spawning populations in the mainstem Sacramento

River and Battle Creek/Coleman National Fish Hatchery depend on the action area during both upstream and downstream migration and rearing.

V. EFFECTS OF THE ACTION

A. Approach to the Assessment

Pursuant to section 7(a)(2) of the ESA (16 U.S.C. 1536), Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. This biological opinion does not rely on the regulatory definition of “destruction or adverse modification” of critical habitat as defined in 50 CFR 402.02. Instead, this biological opinion relies upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat. NMFS will evaluate destruction or adverse modification of critical habitat by determining if the action reduces the value of critical habitat for the conservation of the species. This biological opinion assesses the effects of the proposed RBPP project on endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, threatened Central Valley steelhead, their designated critical habitats, and Southern DPS of North American green sturgeon.

In the section II, “Description of the Proposed Action,” of this biological opinion, NMFS provided an overview of the action. In the sections III and IV, “Status of the Species and Critical Habitat” and “Environmental Baseline,” respectively, NMFS provided an overview of the threatened and endangered species and critical habitat in the action area of this consultation.

Regulations that implement section 7(a)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. 1536; 50 CFR 402.02). Section 7 of the ESA and its implementing regulations also require biological opinions to determine if Federal actions would destroy or adversely modify the conservation value of critical habitat (16 U.S.C. 1536).

NMFS generally approaches "jeopardy" analyses in a series of steps. First, we evaluate the available evidence to identify the direct and indirect physical, chemical, and biotic effects of the proposed action on individual members of the listed species or aspects of the species' environment (these effects include direct, physical harm or injury to individual members of a species; modifications to something in the species' environment - such as reducing a species' prey base, enhancing populations of predators, altering spawning substrate, altering ambient temperature regimes; or adding something novel to a species' environment - such as introducing exotic competitors or noise disturbance). Once we have identified the effects of an action, we evaluate the available evidence to identify a species' probable response (including behavioral responses) to those effects to determine if those effects could reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death,

immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; among others). We then use the evidence available to determine if these reductions, if any, could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

To evaluate the effects of the proposed action, NMFS examined the proposed construction activities, habitat change or loss, and conservation measures, to identify likely impacts to listed anadromous salmonids and green sturgeon within the action area, based on the best available information.

The primary information used in this assessment include fishery information previously described in the “Status of the Species and Critical Habitat” and “Environmental Baseline” sections of this biological opinion; studies and accounts of the impacts of water diversions and in-river construction activities on anadromous species; and documents prepared in support of the proposed action.

B. Assessment

The proposed RBPP project includes activities that may adversely affect several life stages of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, or Southern DPS of North American green sturgeon. Adverse effects to these species and their habitat may result from damage to incubating eggs and harassment of juveniles and adults from pile driving activities, changes in water quality from excavation and construction activities, impingement and entrainment of juveniles inside the cofferdam, and loss of riparian vegetation from construction activities. The project includes integrated design features and avoidance and minimization measures to reduce many of these potential impacts.

Although the purpose of the proposed action is to improve the agricultural water diversion reliability and fish passage problems (*e.g.*, migration delays, mortality, and predation on juveniles) associated with the operation of RBDD, the operation of RBDD, including the new pumping plant, is not addressed here and instead will be addressed in the OCAP biological opinion. In general, however, the proposed RBPP project is expected to increase the flexibility of RBDD operations and reduce the adverse effects of that facility on anadromous fishes. Also, the project is expected to eliminate the need for operation of the Constant Head Orifice to divert water from Stony Creek. Overall, the demand of the TCCA for water is not expected to increase, and the proposed project will not constrain future RBDD operations.

1. Effects Associated with Construction Activities

Impacts to the listed species and their habitats would likely occur from constructing a new pump station at the Mill Site and trenching for the installation of the diversion conveyance pipelines across Red Bank Creek. These impacts include the potential for direct losses, injury, and indirect impacts to adult or juvenile salmon, steelhead, and green sturgeon and their habitats. At the Mill Site, impacts would likely occur from activities related to the grading of the site and excavation of the streambank, the installation of a large (up to approximately 1,400 linear feet) sheet pile cofferdam, and from stranding of fishes within the cofferdammed areas. At the Red Bank Creek

crossing, impacts to fry and juvenile life stages of all species would likely occur from activities related to site grading and preparation, cofferdam installation, and stranding of fish within the cofferdammed areas.

The primary features of construction would be excavation, construction of concrete structures, and fill and re-grading operations. Such activities would require large pieces of equipment, including cranes, front end loaders, pile drivers, back hoes, excavators, scrapers, bulldozers, dump trucks, and other basic construction equipment and tools for digging and moving soil, and pouring concrete. Additionally, because a large portion of the construction activity would occur near the Sacramento River, a sheet pile cofferdam, installed using a pile driver or similar piece of equipment, is necessary to establish dry areas for forming concrete structures. Approximately 2,000 linear feet of sheetpile would be required to construct various cofferdams in several locations.

Construction activities will occur concurrently for 18 months at two locations: at the Mill Site property to construct the fish screen, forebay, main pump station, and associated buildings; and from the Mill Site across Red Bank Creek to the existing TCCA Diversion forebay to construct the diversion conveyance system and outlet structure. Additionally, the road and bridge linking the existing TCCA diversion site to the new Mill Site diversion will be constructed concurrently and require approximately 6 months to complete.

a. Pile Driving

Pile driving will be necessary to install sheet piles to form the cofferdam around the fish screen work areas on the Sacramento River as well as to install the conveyance facilities across Red Bank Creek (Holt 2007c). Pile driving consists of driving steel pile columns and sheets into the riverbed with a mechanical hammer. The force of the hammer hitting a pile forms a sound wave that travels down the pile and causes the pile to resonate radially and longitudinally. Acoustic energy is formed as the walls of the steel pile expand and contract, forming a compression wave that moves through the pile. The outward movement of the pile wall sends a pressure wave propagating outward from the pile and through the riverbed and water column in all directions.

Because inconsistent mediums, such as water, will result in a higher rate of transmission loss, environmental factors such as water depth, water turbulence, air bubbles, and substrate consistency are important to consider when estimating the distance a compression wave will travel. A compression wave traveling through shallow water and substrates with variable consistencies (*i.e.*, variable particle size class distribution) will attenuate more rapidly than compression waves traveling through a constant medium such as deep water or bedrock. As a compression wave moves away from the source, the wavelength increases and intersects with the air/water interface. Once the compression wave contacts the air, it attenuates rapidly and does not return to the water column.

Salmon and steelhead eggs are very fragile, and thus, susceptible to mechanical shock prior to the eyed egg stage (Jensen and Alderice 1983, Piper *et al.* 1982). Chinook salmon eggs generally reach the eyed stage within 19 days of fertilization under typical fall water temperatures of 56°F in the action area (Piper *et al.* 1982). Steelhead eggs generally reach the

eyed stage within 12 days of fertilization under typical winter water temperatures of 48°F in the action area (Velson 1987). During this period of early development, high pressure compression shock waves may cause egg mortality in redds that are close to pile driving activities. In planning for the replacement of the Diestelhorst Bridge in Redding, California, engineering analysis concluded that driving small piles (such as sheet piles) would be likely to kill pre-eyed salmon and steelhead eggs located up to 150 feet from pile driving activities (Rectenwald 2002). River and substrate conditions in the action area generally are expected to be similar to those in the Redding area due to the proximity and similarity in width and character of the Sacramento River at the two locations, although the presence of Lake Red Bluff from April 15 through September 15 and resultant increase in water depth at the RBPP site may decrease the attenuation of the compression waves. As indicated in the “Environmental Baseline” section of this biological opinion, no Sacramento River winter-run Chinook salmon spawning has been observed in the reach just upstream of RBDD (*i.e.*, where pile driving will occur) in recent years. Central Valley steelhead and/or rainbow trout redds have been observed within the action area during aerial redd surveys, although these redds have not been counted or documented (Killam 2005). Some Central Valley spring-run Chinook salmon adults may spawn in this reach, but most Chinook spawning detected in this area are thought to be fall-run Chinook salmon. In addition, over half of spring-run Chinook salmon would be expected to spawn before September 26 (Vogel and Marine 1991), and therefore, be past the eye-up stage when pile driving starts on October 15. Exposure will further be reduced by establishing a 200-foot exclusionary zone around pile driving locations from April 15 through November 15, which covers the primary spawning period of winter- and spring-run Chinook salmon. Overall, the likelihood of exposure of salmonid eggs and larvae to pile-driving from the RBPP project is expected to be very low.

Given this information, NMFS expects that a very small fraction of the total egg production for the Central Valley spring-run Chinook salmon ESU and the Central Valley steelhead DPS will be affected by the proposed pile driving activities, and that the resulting loss of reproductive potential will not be of a magnitude that would appreciably reduce the likelihood of survival and recovery of these species.

(1) Immediate Mortality of Fish from Pile Driving. The effect of pile driving on free-swimming fish depends on the duration, frequency (Hz), and pressure (dB) of the compression wave. Rasmussen (1964) found that immediate mortality of juvenile salmonids may occur at sound pressure levels exceeding 204 dB. Due to their size, adult salmon steelhead and green sturgeon can tolerate higher pressure levels, and immediate mortality rates for adults are expected to be less than those experienced by juveniles (Hubbs and Rechnitzer 1952). As sound pressure levels are not expected to exceed 180 dB, no immediate mortality of juvenile or adult fish is expected. Additionally, during sheet pile installation, adult salmon, steelhead, and/or green sturgeon would likely avoid the areas where these cofferdams are being installed. Death or injury to adults would not likely occur from any percussion impacts, as these adults would disperse from the immediate vicinity of the pile driving.

(2) Pile Driving Impacts on the Auditory Sensory Organs of Fish. High levels of underwater acoustic noises have been shown to have adverse impacts upon the auditory sensory organs of fish within close proximity of the noise source. Scholik and Yan (2002) examined the effects of boat engine noise on the auditory sensitivity of fathead minnow. Fish were exposed to a

recording of the noise generated by a 55 hp outboard motor over a period of 2 hours. The noise level was adjusted to 142 dB, which was equivalent to the noise levels measured at 50 meters from a 70 hp outboard motor. The experimental fish suffered a drop in hearing sensitivity over the range of frequencies normally associated with their hearing capabilities. These responses were measured using electrophysiological responses of their auditory nerves under general anesthesia. Studies by McCauley *et al.* (2003) on the marine pink snapper indicated that high-energy noise sources (approximately 180 dB maximum) can damage the inner ears of aquatic vertebrates by ablating the sensory hairs on their inner ear epithelial tissue as revealed by electron microscopy. Damage remained apparent in fish held up to 58 days after exposure to the intense sound. Although no studies utilizing salmonids have been conducted, auditory effects on these other fish species can serve as surrogates for salmonids, and it is reasonable to assume that some level of adverse impacts to salmonids can be inferred from the above results if they are subjected to similar intensities and durations of noise.

The loss of hearing sensitivity may negatively affect a salmonid's ability to orient itself (*i.e.*, due to vestibular damage), detect predators, locate prey, or sense their acoustic environment. Chronic noise exposure can reduce a fish's ability to detect piscine predators either by reducing the sensitivity of the auditory response or by masking the noise of an approaching predator. Disruption of the exposed fish's ability to maintain position or swim with the school will enhance its potential as a target for predators. Unusual behavior or swimming characteristics single out an individual fish and allow a predator to focus its attack upon that fish more effectively.

Impacts to larvae/post-larvae, fry, or juvenile life stages present near the Mill Site would likely occur during installation of cofferdams from pile driving activities. Direct physical loss or injury and indirect impacts from stress would likely occur during installation of sheet pile cofferdams. Some juvenile salmon, steelhead, or larval/post-larval green sturgeon would likely be killed or injured from the percussion impacts during sheet pile installation.

(3) Behavioral Responses to Pile Driving. Behavioral responses to high noise levels (startle response, avoidance, agitation, *etc.*) have been studied in salmonids with mixed results. Burner and Moore (1962) found that large juvenile and adult fish rarely responded to sudden or loud sound stimuli. Goetz *et al.* (2001) and Ploskey and Johnson (2001) found no difference between the reactions of treatment groups of Chinook salmon and coho salmon (*O. kisutch*) exposed to no sound and groups exposed to sounds reaching 170-180 dB.

Other experiments by McKinley and Patrick (1988) using pulsed sound, similar to pile driving, found that smaller juvenile salmonids demonstrated a startle or avoidance response. Feist *et al.* (1992) found that salmonids hear within a range of 10 to 400 Hz, with the greatest sensitivity between 180 and 190 Hz, and that pile-driving in Puget Sound created sound within the range of salmonid hearing that could be detected at least 600 m away. Abundance of juvenile salmon near pile driving rigs was reduced on days when the rigs were operating compared to non-operating days. Also, Shin (1995) found that pile driving may result in "agitation" of salmonids as indicated by a change in swimming behavior. These studies suggest that pile driving may cause startling and/or avoidance of habitat by fish in the immediate vicinity of a project site.

The startling of fish can cause injury by temporarily disrupting normal behaviors that are essential to growth and survival such as feeding, sheltering, and migrating. Injury is caused when disrupting these behaviors increases the likelihood that individual fish will face increased competition for food and space, and experience reduced growth rates or possibly weight loss. Disruption of these behaviors may also result in the death of some individuals due to increased predation if fish are disoriented or concentrated in areas with high predator densities. Disruption of these behaviors may occur for specific periods between October 15 and April 15 of each construction year, during daylight operation hours of the pile driving hammer. Downstream movement of fry occurs mainly at night, although small numbers of Chinook salmon fry move during daylight hours (Reimers 1973). Because of this nocturnal migratory behavior, daily migration delays are expected to impact only the portion of each ESU/DPS that migrates during daylight hours in the periods that pile driving activities are occurring. Lapses in pile driving activity are common throughout the day because construction crews suspend hammer work for equipment maintenance, to shift from one pile to another, and to take breaks (Whitley 2002). These construction lapses, including daily breaks and nighttime non-working periods, as well as long periods when no pile driving is scheduled to occur, will allow fish to migrate through the action area and minimize the extent of injury that occurs to populations.

The population-level effects of harassment to adult and juvenile Chinook salmon, steelhead and green sturgeon are expected to be limited in part, because pile driving activities will occur during the day, enabling unhindered fish passage at night. Also, the October 15 through April 15 percussive work window will avoid the primary spawning periods for winter and spring-run Chinook salmon and green sturgeon, as well as the primary outmigration period for juvenile winter-run Chinook salmon (July through October) and green sturgeon (June through September). Additionally, many subpopulations of Central Valley spring-run Chinook salmon and Central Valley steelhead occur in tributaries downstream of the action area (*e.g.*, Deer, Mill, and Butte Creeks, Yuba and Feather Rivers, *etc.*) and, therefore, are not expected to be affected by the proposed RBPP project at all.

b. Cofferdams Installation and Operation

Closure of cofferdams may entrap winter-run Chinook salmon, spring-run Chinook salmon, steelhead and green sturgeon. Cofferdam installation is expected to take 4 to 6 weeks. As specified in the proposed conservation measures, pile driving will be limited to the period from January 15 to November 15, and the detection of salmonid spawning habitat within the 200-foot exclusionary zone around pile driving locations will require additional precautions during the period from April 15 through November 15 (*i.e.*, ensuring that anti-spawning mats are in place prior to April 15 to prevent spawning in the area). The cofferdam installation process will likely startle most of the salmon near the construction site and cause them to leave the immediate area of work. However, some fish may be entrained when the cofferdam is closed. Direct losses, injuries, and stress to larval/post-larval, fry, and juvenile life stages could occur from isolation and stranding during the installation of cofferdams and from de-watering of the cofferdammed area.

Implementation of a fish salvage operation within the closed cofferdams will reduce potential mortality associated with entrapment and subsequent dewatering of the dammed area. Any fish

salvaged from the cofferdammed area would be relocated to the main stream channel. A low mortality rate (expected to be less than 10 percent if consistent with the results of fish handling in similar fish salvage efforts) is expected from capturing and handling.

c. In-stream Work

In-stream work, at both the Mill Site in the Sacramento River and the bridge site in Red Bank Creek, could increase suspended sediments and elevate turbidity above natural levels in the water column downstream of the construction areas. Activities that could contribute sediment and increase turbidity include sheet pile driving and removal, and use of near-river access roads and staging areas. Because the vast majority of instream construction activities will occur behind closed cofferdams, the potential for the project to cause significant increases in downstream turbidity levels is very low. While unlikely, there is always the potential for an unexpected storm event or other unplanned problem to result in the discharge of sediments from the project site.

High turbidity can affect fish by reducing feeding success, causing avoidance of rearing habitats, and disrupting upstream and downstream migration. Displacement of juveniles from preferred habitats may result in increased susceptibility to predation. Bisson and Bilby (1982) reported that juvenile coho salmon avoid turbidities exceeding 70 nephelometric turbidity units (NTUs), and Sigler *et al.* (1984) found that turbidities between 25 and 50 NTUs reduced growth of juvenile coho salmon and steelhead. Turbidity should affect Chinook salmon in much the same way it affects juvenile steelhead and coho salmon because of similar physiological and life history requirements between the species. Increased sediment delivery and high levels of turbidity also can cause infiltration of fine sediment into spawning gravels. This can lead to decreased substrate permeability and intergravel flow, resulting in oxygen depletion and mortality of incubating eggs and pre-emergent fry (Lisle and Eads 1991). Increased sediment delivery can also fill interstitial substrate spaces resulting in reduced abundance and availability of aquatic invertebrates for food (Bjornn and Reiser 1991).

Adherence to the preventative and contingency measures of the Stormwater Pollution Prevention Plan (SWPPP) will minimize the potential for project related-sediment plumes to be caused by unexpected storms or similar issues by removing excavation materials to locations outside of the river channel and halting work in the event of a plume being detected. Sediment management and preventative measures will minimize the amount of project-related sediment introduced to the waterway through the use of cofferdams, silt fences, straw mulch, and erosion control seeding. These measures are further described in section V.C, "Measures to Reduce the Impacts of Construction of the Project Facilities," below. In the event that a project-related sediment plume does occur, it is expected to be of short duration, since work would be suspended, and the plume would likely dissipate quickly downstream when mixed with the large volume of the Sacramento River. The sediment plume would be expected to result in a temporary change in the distribution of fish in the action area, lasting only as long as the plume was present.

Water quality may also be affected by hydraulic and fuel line leaks and petroleum spills. NMFS expects that the risk of introducing petroleum products or pollutants other than sediment to the waterway will be sufficiently minimized because the SWPPP will contain prevention and

contingency measures requiring frequent equipment checks to prevent leaks, keeping stockpiled materials away from the water, and requiring that absorbent booms are kept onsite to prevent petroleum products from entering the river in the event of a spill or leak.

These types of events are unlikely to affect migrating adults to the extent of injuring them, but may injure some juvenile fish, which are actively feeding and growing by temporarily disrupting normal behaviors that are essential to growth and survival. Injury would be caused when disruption of these behaviors increases the likelihood that individual fish will face increased competition for food and space, and experience reduced growth rates or possibly weight loss. Project-related turbidity increases may also affect the sheltering abilities of some juvenile fish and may decrease their likelihood of survival by increasing their susceptibility to predation. However, because of the short duration of the turbidity events, the low levels of injury and death that may occur to listed species from changes in feeding behavior, distribution and predation, are not expected to result in appreciable reductions in the species' likelihood of survival and recovery in the wild.

(1) *Habitat Loss or Alteration.* The permanent loss or alteration of an approximately 1,400-foot by 10-foot area of stream bank and water column habitat in the Sacramento River would occur from construction of the proposed fish screen facility at the Mill Site. Alteration of habitat would occur from the presence of a fish screen with some low probability of impingement or entrainment as well as increased vulnerability to predation by striped bass and pikeminnow. Additionally, the permanent alteration of an approximately 100-foot by 17-foot area of the wetted stream channel of Red Bank Creek and the permanent loss or alteration of an approximately 580-foot by 17-foot area of riparian habitat adjacent to Red Bank Creek would occur from construction of the new bridge. The bridge will span Red Bank Creek, so the only alterations to the wetted channel would include increased shading from the bridge, loss of shade and allochthonous input from existing trees that will have to be removed, and potentially increased traffic noise. However, because of the degraded condition of riparian habitat along the Mill Site, the small size of the other affected areas, the implementation of the proposed avoidance and minimization measures described in section II.C, "Proposed Avoidance and Minimization Measures," the limited term of the expected impacts, the abundance of other forms of overhead cover and shade (*e.g.*, pools, riffles and the bridge itself), and adequate aquatic food production, NMFS does not expect the reduction in riparian habitat values to appreciably reduce the listed species' likelihood of survival and recovery in the wild.

2. Effects of Project Operation and Maintenance

Because the proposed RBPP will be a part of the infrastructure of the CVP, the future operation and maintenance of the project facilities are being appropriately addressed within the consultation for OCAP for the CVP. Therefore, the effects of future project operations and maintenance are not analyzed in this biological opinion.

C. Measures to Reduce the Impacts of Construction of the Project Facilities

The avoidance and minimization measures proposed by Reclamation and described in section II.C, "Proposed Avoidance and Minimization Measures," would offset or avoid many of the potential impacts of implementing the RBPP project.

Reclamation has proposed the following avoidance and minimization measures to address potential project-related impacts to fish resources (CH2MHill 2001).

- Placement of sheet pile (in-stream work) would take place in July and August.
- Potential suitable spawning areas identified within 200 feet of pile-driving locations would have anti-spawning mats securely installed at least 90 days prior to pile-driving activities. These mats would remain in place throughout construction activities to discourage adult fish from spawning in the immediate vicinity of the construction area.
- All dewatered areas within cofferdams would be pumped down using a screened intake on the dewatering pumps. Pumping would continue until water levels within the contained areas are suitable for salvage of any juvenile or adult fish occupying these areas. Fish would be removed by methods approved by NMFS and CDFG prior to final dewatering.
- The construction contractor shall obtain a General Construction Storm Water Permit, to comply with the Clean Water Act, section 402(b) for construction of all facilities. As part of this permit, the contractor would prepare an erosion control plan as part of the SWPPP, which would include the following BMPs:
 - All ground-disturbing activities would be limited to the dry season (mid-May through mid-October) to the extent possible;
 - Existing vegetation would be left in place to the degree possible to reduce potential sedimentation;
 - All stockpiled material would be placed so that potential for erosion is minimized;
 - Filter fabric, straw bales, and/or sediment basins would be used to reduce erosion and the potential for instream sedimentation; and
 - Seeding and re-vegetation would be initiated as soon as possible (timed properly to coincide with fall/winter precipitation) after construction completion.
 - To the extent possible, areas of riparian vegetation temporarily disturbed during construction would be planted with native riparian trees and shrubs to restore the impacted habitat following construction. The permanent removal of riparian vegetation would be mitigated by creating riparian habitat at a 3:1 ratio for impacted acreage. Reclamation will work with NMFS, CDFG and USFWS to identify appropriate locations for riparian habitat creation and restoration to compensate for permanent impacts in the action area. The acreage of riparian habitat impacted would be determined based on final design drawings.
- Placement of cofferdams to isolate construction activities that have the potential for discharging soils and sediments into the active channel.
- Implement bank excavation techniques to minimize and prevent, to the greatest extent possible, soil material from entering the active channel.
- Monitor turbidity during cofferdam placement and construction to ensure that they do not result in increased turbidity that would have deleterious effects on listed species in the action area.
- Ceasing construction activities when turbidity approaches or exceeds acceptable criteria established by the Central Valley Regional Water Quality Control Board (CVRWQCB).

Construction activities may resume only after turbidity levels downstream of the project construction site return to acceptable levels established by the CVRWQCB.

- Any heavy equipment necessary for installation or removal of sheet pile cofferdams would be operated from either a floating barge or from the top of the streambank.
- No more than one vehicle with tracks or wheels would be permitted to enter or operate within any wet portion of the stream channel at any time.
- All vehicles operated within the wet portion of the stream channel would enter and exit the active channel through one location (access point).
- All other vehicles accessing work areas adjacent to and within the wet portion of the stream channel would be operated on existing roads, hardened access ramps, or within contained areas inside cofferdams.
- Any vehicle operated within the wet portion of the stream channel should be free of petroleum residues, and any vehicle's fuel, lubricant, and/or fluids should be contained within watertight reservoirs.
- Operation of any vehicle within the wet portion of the stream channel should be minimized and only as necessary to accomplish construction-related tasks.

D. Beneficial Effects of the RBPP Project

Although the operation of RBDD will be addressed in the OCAP consultation, the proposed project would provide operational flexibility to RBDD for adult and juvenile listed species, and provide reliable water delivery to TCCA.

E. Interrelated or Interdependent Actions

Regulations that implement section 7(b)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. 1536; 50 CFR 402.02). There are no interrelated or interdependent actions associated with the proposed action.

VI. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

The only cumulative effects of future (and current) State, local and private actions that are reasonably certain to occur in the action area are those of global climate change. The future effects of global climate change in the action area are expected to be similar to those described for the entire range of the listed species in Section III. C. 1. c. Increases in rainfall and decreases in snow pack in the southern Cascades will affect cold-water pool storage in Shasta reservoir, upstream of the action area, affecting river hydrology, flow patterns and water

temperatures in the action area. As the action area is already the downstream-most extent of suitable water temperatures for winter- and spring-run Chinook salmon spawning (only in the coldest water years), it is likely that the projected increase in water temperatures will render the action area unsuitable for Chinook salmon spawning during the summer and early fall months (winter- and spring-run Chinook salmon spawning periods).

VII. INTEGRATION AND SYNTHESIS

The purpose of this section is to summarize the effects of the action and add those effects to the impacts described in the “Environmental Baseline” and “Cumulative Effects” sections of this biological opinion in order to inform the conclusion of whether or not the proposed action is likely to jeopardize the continued existence of the listed salmonids and North American green sturgeon, or destroy or adversely modify designated critical habitat.

Populations of Chinook salmon, steelhead and green sturgeon in California have declined drastically over the last century, and some subpopulations have been extirpated. The current status of listed salmonids within the action area, based upon their risk of extinction, has not significantly improved since the species were listed (Good *et al.* 2005). For example, although the number of Sacramento River winter-run Chinook salmon has increased in the last 6 years, the ESU remains at risk of extinction (Good *et al.* 2005). This severe decline in population over many years, and in consideration of the degraded environmental baseline, demonstrates the need for actions which will assist in the recovery of all of the ESA-listed species in the action area, and that if measures are not taken to reverse these trends, the continued existence of salmonids and sturgeon could be at risk.

NMFS expects that the RBPP project will result in short-term construction-related impacts that will injure, harm and possibly kill mainly juveniles, but possibly larvae/post-larvae and fry life stages, of the listed salmonids and Southern DPS of North American green sturgeon and remove or alter their habitat. However, the adverse effects to these listed species within the action area are not expected to affect the overall survival and recovery of the ESUs and DPS. This is largely due to the fact that Reclamation will implement measures outlined in section II.C, “Proposed Avoidance and Minimization Measures,” as part of the proposed project to avoid, minimize, or mitigate any temporary and permanent habitat losses and other construction-related disturbances. The number of individuals actually injured or killed is expected to be small in proportion to the sizes of the respective populations. Therefore, population-level impacts are not anticipated. Overall, construction-related impacts to the listed species will be temporary and will not impede adult fish from reaching upstream spawning and holding habitat, or juvenile fish from migrating to downstream rearing areas.

The cumulative effects of global climate change are not expected to be additive to the temporary, construction-related effects of the proposed project because project effects are expected to have fully dissipated prior to the period when significant climate change effects are projected to occur in the action area.

VIII. Conclusion

After reviewing the best scientific and commercial information available, the current status of the species, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects, it is NMFS' biological opinion that the RBPP project, as proposed, is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, or Southern DPS of North American green sturgeon. In addition, NMFS has determined that the RBPP project, as proposed, is not likely to destroy or adversely modify critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibits the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not the purpose of the agency action is not considered to be prohibited taking under the ESA, provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The listing of the Southern DPS of North American green sturgeon became effective on July 7, 2006, and some or all of the ESA section 9(a) prohibitions against take will become effective upon the future issuance of protective regulations under section 4(d). Because there are no section 9(a) prohibitions at this time, the incidental take statement, as it pertains to the Southern DPS of North American green sturgeon, does not become effective until the issuance of a final 4(d) regulation, as appropriate.

The measures described below are non-discretionary, and must be undertaken by Reclamation so that they become binding conditions of any contract, grant or permit, as appropriate, for the exemption in section 7(o)(2) to apply. Reclamation has a continuing duty to regulate the activity covered by this incidental take statement. If Reclamation: (1) fails to assume and implement the terms and conditions, or (2) fails to require the contractors to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the contract, permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Reclamation must report the progress of the action and its impact on the species to NMFS as specified in the incidental take statement [50 CFR 402.14(i)(3)].

A. Amount and Extent of Take

NMFS anticipates incidental take of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and the Southern DPS of North American green sturgeon from impacts related to construction of the RBPP project as a result of reductions in the quality or quantity of their habitat.

NMFS cannot, using the best available information, accurately quantify the anticipated incidental take of individual listed fish because of the variability and uncertainty associated with the population size of each species, annual variations in the timing of migration, and uncertainties regarding individual habitat use of the action area. However, it is possible to designate ecological surrogates for the extent of take anticipated to be caused by the RBPP project, and to monitor those surrogates to determine the level of take that is occurring. The four most appropriate ecological surrogates for the extent of take caused by the RBPP project are: the amount, duration and timing of pile driving associated with instream cofferdam construction; the mortality rate of fish rescued from within cofferdams; the turbidity levels produced by instream construction activities; and the 3:1 replacement of permanently impacted riparian habitat.

1. Ecological Surrogates

- The analysis of the effects of the proposed RBPP project anticipates that a maximum of 2200 linear feet of sheet piling will be driven over a period of 6 weeks to create the necessary cofferdams, and that pile driving will occur only during daylight hours.
- The analysis of the effects of the proposed RBPP project anticipates that the mortality rates of fish rescued from within cofferdams are not expected to exceed 10 percent of all listed species detected within the enclosed areas.
- The analysis of the effects of the proposed RBPP project anticipates that the turbidity levels produced by instream construction activities will not exceed those permitted under the project SWPPP and that if turbidity levels approach or exceed the acceptable criteria established by the CVRWQCB, construction activities will be halted until turbidity levels return to within acceptable levels.
- The analysis of the effects of the proposed RBPP project anticipates that permanently impacted riparian vegetation will be replaced at a 3:1 ratio with appropriate, native riparian habitat that will be protected in perpetuity.

If these ecological surrogates are not met and maintained, the proposed RBPP project will be considered to have exceeded anticipated take levels, triggering the need to reinstate consultation on the RBPP project.

B. Effect of the Take

NMFS has determined that the level of take associated with the implementation of the RBPP project is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, or the Southern DPS of North American green sturgeon.

C. Reasonable and Prudent Measures

NMFS believes that the following reasonable and prudent measures are necessary and appropriate to minimize take of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and Southern DPS of North American green sturgeon resulting from implementation of the action. These reasonable and prudent measures also would minimize adverse effects on designated critical habitat:

1. Reclamation shall minimize noise-related impacts resulting from pile driving of sheet piles for cofferdams.
2. Reclamation shall take the necessary measures to maintain and adaptively manage all conservation measures throughout the life of the project to ensure their long-term effectiveness.

D. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, Reclamation must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline specific reporting and monitoring requirements. These terms and conditions are nondiscretionary.

1. Reclamation shall minimize noise-related impacts resulting from pile driving of sheet piles for cofferdams.
 - a. In order to minimize the magnitude of sound and energy waves produced during pile driving, Reclamation shall mandate that vibratory hammers be used for sheet pile driving wherever it is feasible to do so (where substrate allows the use of vibratory hammers to drive sheet piles).
2. Reclamation shall take the necessary measures to maintain and adaptively manage all conservation measures throughout the life of the project to ensure their long-term effectiveness.
 - a. Reclamation shall minimize bank revetment (riprap) at the Mill Site to the minimum length needed for hydraulic performance and structural integrity of the fish screen.
 - b. Reclamation shall implement the selected mitigation options prior to, or concurrent with, project construction to expeditiously replace habitat values lost due to the proposed project.

- c. Reclamation shall develop and implement, in cooperation with the USFWS, NMFS, CDFG, and TCCA, an evaluation and monitoring plan to assess the adequacy of the fish screen in meeting biological and engineering design criteria and propose corrective measures. Reclamation shall:
 - o Monitor screen criteria for the period of time necessary to evaluate screen performance at a range of river flows and pumping rates;
 - o Identify operational flexibilities that would provide the greatest level of fisheries protection at various river flows and pumping rates; and
 - o Perform biological evaluations using available technology (direct observation, video, acoustic/sonar, *etc.*) as appropriate, to evaluate the effectiveness and/or impacts of the screens to juvenile salmonids and other target species.
- d. Reclamation shall provide a project summary and compliance report to NMFS at the end of each calendar year until the RBPP project and all terms and conditions have been implemented. This report shall describe construction dates, implementation of avoidance and minimization measures, and the terms and conditions of the biological opinion; observed or other known effects on Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and the Southern DPS of North American green sturgeon, if any; and any occurrences of incidental take of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and the Southern DPS of North American green sturgeon.
- e. Reports shall be submitted to:
 - Sacramento Area Office
 - National Marine Fisheries Service
 - 650 Capitol Mall, Suite 8-300
 - Sacramento California 95814-4706
 - Phone: (916) 930-3600
 - FAX: (916) 930-3629

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations applicable to the RBPP project to address specific limiting factors have been identified for the listed salmonids and Southern DPS of North American green sturgeon include the following:

1. Reclamation should initiate year-round gates-up operation of RBDD once the RBPP is fully operational.
2. Once the RBPP is fully operational, and the TCC is able to get its full water allotment from this facility throughout the year, Reclamation should dedicate available CVP water stored in Black Butte Reservoir (currently used to supplement TCC supplies when RBDD gates are raised) as instream flows to improve salmonid habitat in lower Stony Creek.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, NMFS requests notification of implementation of any conservation recommendations.

XI. REINITIATION OF CONSULTATION

This concludes formal consultation for the RBPP project in Tehama County, California. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

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Magnuson-Stevens Fishery Conservation and Management Act

ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS

I. IDENTIFICATION OF ESSENTIAL FISH HABITAT

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), as amended (U.S.C. 1801 *et seq.*), requires that Essential Fish Habitat (EFH) be identified and described in Federal fishery management plans (FMPs). Federal action agencies must consult with NOAA's National Marine Fisheries Service (NMFS) on any activity which they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies.

EFH is defined as those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purposes of interpreting the definition of EFH, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and, "spawning, breeding, feeding, or growth to maturity" covers all habitat types used by a species throughout its life cycle. The action area of the Red Bluff Pumping Plant project is within the area identified as EFH for Pacific Coast Salmon species identified in Amendment 14 of the Pacific Salmon FMP [Pacific Fishery Management Council (PFMC) 1999].

PFMC (1999) has identified and described EFH, and has identified adverse impacts and recommended conservation measures for salmon in amendment 14 to the Pacific Coast Salmon FMP. Freshwater EFH for Pacific salmon in the California Central Valley includes waters currently or historically accessible to salmon within the Central Valley ecosystem as described in Myers *et al.* (1998). Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), and Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) are species managed under the Pacific Coast Salmon FMP that occur in the Central Valley.

A. Life History and Habitat Requirements of Pacific Salmon

General life history information for Central Valley fall-/late-fall Chinook salmon is summarized below. Information on Sacramento River winter-run and Central Valley spring-run Chinook salmon life histories is summarized in the preceding biological opinion for the proposed project (enclosure 1). Further detailed information on Chinook salmon Evolutionarily Significant Units (ESU) are available in the NMFS status review of Chinook salmon from Washington, Idaho, Oregon, and California (Myers *et al.* 1998), and the NMFS proposed rule for listing several ESUs of Chinook salmon (March 9, 1998, 63 FR 11482).

Adult Central Valley fall-run Chinook salmon enter the Sacramento and San Joaquin Rivers from July through December and spawn from October through December, while adult Central Valley late fall-run Chinook salmon enter the Sacramento and San Joaquin Rivers from October to April and spawn from January to April [U.S. Fish and Wildlife Service (USFWS) 1998].

Chinook salmon will spawn in water that ranges from a few centimeters to several meters deep provided that there is suitable sub-gravel flow (Healey 1991). Spawning typically occurs in gravel beds that are located in marginally swift riffles, runs and pool tails with water depths exceeding one foot and velocities ranging from one to 3.5 feet per second. Preferred spawning substrate is clean loose gravel ranging from one to four inches in diameter with less than 5 percent fines (Reiser and Bjornn 1979).

Egg incubation occurs from October through March (Reynolds *et al.* 1993). Shortly after emergence from their gravel nests, most fry disperse downstream towards the Delta and into the San Francisco Bay and its estuarine waters (Kjelson *et al.* 1982). The remaining fry hide in the gravel or station in calm, shallow waters with bank cover such as tree roots, logs, and submerged or overhead vegetation. These juveniles feed and grow from January through mid-May, and emigrate to the Delta and estuary from mid-March through mid-June (Lister and Genoe 1970). As they grow, the juveniles associate with coarser substrates along the stream margin or farther from shore (Healey 1991). Along the emigration route, submerged and overhead cover in the form of rocks, aquatic and riparian vegetation, logs, and undercut banks provide habitat for food organisms, shade, and protect juveniles and smolts from predation.

II. PROPOSED ACTION

The proposed action, the Red Bluff Pumping Plant project, is described in section II (*Description of the Proposed Action*) of the preceding biological opinion (enclosure 1). In general, the Bureau of Reclamation proposes to construct a new pump station with fish screen at the Mill Site, and install a conveyance facility across Red Bank Creek to convey water from the pump station to the Tehama-Colusa Canal, on the right bank of the Sacramento River in Red Bluff, California.

III. EFFECTS OF THE PROJECT ACTION

The effects of the proposed action on Sacramento River winter-run and Central Valley spring-run Chinook salmon habitat are described at length in section V (*Effects of the Action*) of the preceding biological opinion, including the loss of riparian vegetation, temporal loss of spawning habitat, and temporal loss of access to areas to be cofferdammed, and are generally expected to apply to Pacific Coast Salmon EFH.

IV. CONCLUSION

Based on the best available information, NMFS believes that the proposed Red Bluff Pumping Plant project would adversely affect EFH for Pacific salmon.

V. EFH CONSERVATION RECOMMENDATIONS

NMFS recommends terms and conditions 1, 2.a, and 2.b from the preceding biological opinion (enclosure 1) be adopted as EFH Conservation Recommendations.

VI. STATUTORY REQUIREMENTS

Section 305(b)(4)(B) of the MSFCMA requires that the Federal agency provide NMFS with a detailed written response within 30 days, and 10 days in advance of any action, to the EFH conservation recommendations, including a description of measures adopted by the Federal agency for avoiding, minimizing, or mitigating the impact of the project on EFH [50 CFR 600.920(j)]. In the case of a response that is inconsistent with our recommendations, Reclamation must explain its reasons for not following the recommendations, including the scientific justification for any disagreement with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, or mitigate such effects.

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